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**MULTIMEDIA
ON
U.S. NAVY NETWORKS**

by

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The optimization of information management resources is crucial to Navy information processing. Multimedia's innate ability to place complex concepts into forms that are more naturally familiar to the user has a relevant role to play in the optimization process. Before this optimum state can be attained, however, knowledge of the present state and a vision of the desired target state are needed. To this end, this thesis reviews recent developments and emerging trends in distributed multimedia applications. It first examines the breadth of the field with the intent of identifying those multimedia applications that have the greatest potential for adaption to U.S. Navy use. The focus then narrows to applications that are currently employed by Navy distributed systems. Strategic thinking, with an emphasis on cost, goals, and return on investment, should always be the basis for considering any new information system. The effects of change on personnel should be a principal concern. Finally, optimization will not occur without a high degree of cooperation at all levels of the military.

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MULTIMEDIA
ON
U.S. NAVY NETWORKS

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ABSTRACT

The optimization of information management resources is crucial to Navy information processing. Multimedia's innate ability to place complex concepts into forms that are more naturally familiar to the user has a relevant role to play in the optimization process. Before this optimum state can be attained, however, knowledge of the present state and a vision of the desired target state are needed. To this end, this thesis reviews recent developments and emerging trends in distributed multimedia applications. It first examines the breadth of the field with the intent of identifying those multimedia applications that have the greatest potential for adaption to U.S. Navy use. The focus then narrows to applications that are currently employed by Navy distributed systems. Strategic thinking, with an emphasis on cost, goals, and return on investment, should always be the basis for considering any new information system. The effects of change on personnel should be a principal concern. Finally, optimization will not occur without a high degree of cooperation at all levels of the military.

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I. INTRODUCTION

A. BACKGROUND

Multimedia is an emerging technology that is receiving much attention throughout the information management industry. Its growth over the past few years has been phenomenal. Multimedia's ability to combine text, audio, still images, and video into a cohesive unit has sparked interest in both the business office and home consumer markets (Vervest and Sherwood-Roberts, 1994). The interest is so intense that many information specialists predict that a multimedia revolution is in the making (Long and Long, 1993).

The term "multimedia" itself is a source of confusion because it is used to describe a variety of products. Everything from CD-ROM based games to high-resolution monitors have been called multimedia. With no official definition to rely upon, the one that will be used throughout this study refers to an information system that integrates text, high-resolution still graphics, video, and sound.

Multimedia is not just a passing fad or a technology of minor importance. Because of its inherent capability to present information with considerable impact and power, multimedia makes an excellent choice for service as the link between users and organizational information systems. Organizations view it as a means to improved interactivity - a way to offer the intelligent automated support needed for improved group action. Users, in contrast, see improved efficiency and effectiveness of internal communications as its greatest advantage. (Vervest and Sherwood-Roberts, 1994)

Information systems have become incredibly complex. Unfortunately, the knowledge and skill-level of the average user has not been able to keep abreast of the evolution in information technology. This inability to remain current usually results in considerable under-utilization of information management assets and unnecessary

waste. Multimedia, with its innate ability to simplify user interfaces, should make complex programs more available to the average user. This is a big improvement over the typed commands that so many people have found difficult to understand and hard to remember. (Vervest and Sherwood-Roberts, 1994)

B. MULTIMEDIA: USER SUPPORT

In the end, the great strength of multimedia will lay in its ability to support the user. Bob Runge, director of product marketing at Sybase, Incorporated, contends that multimedia is most needed by users who are not technically oriented. These users find automated systems much more useful when information is available to them in a more natural form. Users who have a greater grasp of technology but are working in areas that do not exclusively use traditional alphanumerics also benefit from the incorporation of multimedia into their work. In these cases, the use of multimedia can make conceptually difficult material easier to understand. (Dickey, 1994)

Much of the development in multimedia has been on stand-alone systems. Until recently, the technology did not exist to transmit bandwidth-hungry multimedia files over extended networks. With the advent of advanced telecommunications technology, however, multimedia capabilities are becoming standard features on networked systems. (Williams and Blair, 1992)

The end users' behavior is changing, albeit at a much slower pace than that of the technology itself. The use of personal computers in the office and at home, as well as the increasing availability of interactive services, are propelling the average user to new levels of understanding and skill. Even the video games that are so popular with the young are having an effect. Interaction, rather than passive viewing, is no longer a novelty, but the expected norm. The result of this interactive background is an advanced level of expectations on the part of the user. The information specialist is finding that keeping up with demands for extended capabilities at the user level is most challenging. (de Boisseson, 1994)

To say that we are poised on the edge of an information technology revolution would be a misnomer. We are right in the middle of it. Even though multimedia will rarely, if ever, be the primary selling feature for computer applications, it is a principle player in the revolution. It will be embedded in future generations of applications, eventually reaching all layers of software (Libincott, 1990).

C. OBJECTIVE

Business and government organizations are just now beginning to recognize the potential value of multimedia. From its beginnings as an electronic curiosity, multimedia was quickly adapted to entertainment and training applications, eventually gaining status as an accepted tool in the networked office environment. Many industry experts pin their hopes for future growth on multimedia. The speed at which multimedia technology is transitioning from novelty to technology base is staggering. Even though there is still much about it that remains ambiguous, it is clear that multimedia is becoming a major player in the information technology world.

The objective of this thesis is to examine the impact that multimedia is having in the U.S. Navy. The potential benefits and costs of the technology need to be explored if the technology is to be adapted to Navy purposes. One way to do that is to look at the manner in which other organizations are using multimedia. The possibility that similar systems can be developed for, or the same systems migrated to, Navy networks should be explored.

Multimedia is not new to the Navy. Telecommunication, teleconferencing, and virtual reality training, for example, are accepted practices within the service. This study will review the Navy's current usage of multimedia and suggest future directions for networked multimedia applications in the Navy.

The principle research question is to determine how the U.S. Navy can optimize its use of multimedia applications in the near-term future. In order to properly answer that question, the current state of multimedia must be examined. We must first determine what multimedia applications are now available and what

applications are currently under development. We will then narrow our focus to the use of multimedia within the U.S. Navy. Both present uses and ongoing developments will be reviewed.

In summary, the research questions are listed below:

- What multimedia applications are currently available?
- What forms of multimedia applications are under development?
- How is the Navy making use of multimedia applications?
- How will the Navy make use of multimedia applications in the near-term future?

D. SCOPE OF THE THESIS

This thesis concentrates on those multimedia applications that are placed on networked systems. Although much can be said about stand-alone computers and the applications found therein, today's challenge is the installation of these complex applications in shared environments. It is in this setting that multimedia will have the greatest impact on the way the U.S. Navy does business in the future.

Conspicuous by its absence within the thesis is any treatment of the Internet. Even though the Internet is already having a profound effect on multimedia and business operations in general, I have elected not to address this environment in the thesis. Issues of privacy and security tend to dominate both business and military discussions of the subject. Proper treatment of these issues is quite voluminous and beyond the scope of this study.

The thesis also concentrates on business applications of multimedia to the exclusion of embedded systems. The multimedia systems found in weapons systems, for example, have not been reviewed. Treatment of these systems would detract from the principal topic of the thesis, that of Navy business applications.

It should also be noted that there is no attempt to produce an all-inclusive list of multimedia products that are currently in use by the Navy. The results would not

justify the extensive effort needed to form the list. The value of the programs that have been included is to serve as an indication of the types of applications that have the potential to positively impact the Navy's business practice methods.

E. THESIS ORGANIZATION

Chapter II provides background information on multimedia. Information on the state of the industry is reviewed with an emphasis on the challenges currently facing the industry. The difficulties encountered when multimedia is applied to networked environments is of particular concern in Chapter II. It concludes with a look at possible future uses of multimedia.

Chapter III surveys the current state of the art and emerging applications. Due to their potential influence on Navy operations, teleconferencing, multimedia messaging, interactive television, and virtual reality are reviewed. As with Chapter II, the focus is on multimedia in networked environments.

Chapter IV focuses on the Navy. It looks at multimedia from a functional point of view. Communication, training, data base management, industrial design and testing, and research and development are discussed. Both available applications and those in development are examined.

Chapter V uses all of the previous information to draw conclusions concerning directions that the Navy should take and its future involvement with multimedia. Of particular interest is the convergence of networking and multimedia technologies. The Navy's role in developing multimedia and the importance of people within the system are also discussed. The chapter concludes with a statement of the importance of adopting this promising new technology.

II. MULTIMEDIA: AN OVERVIEW OF TRENDS

Multimedia is a tool that effectively conveys information and knowledge to people (Vervest and Sherwood-Roberts, 1994). Often referred to as "next revolution in microcomputers," corporate America has a high degree of incentive for investing in this emerging industry. The computing, television, and communication industries anticipate an intense and volatile multimedia market and are already queuing for a chance to obtain their share of the multimedia market. (Libincott, 1990)

What makes multimedia processing so difficult is that it encompasses two opposing concepts, "variety" and "integration." Variety refers to the different media types that are quickly becoming such an important feature of modern information systems. This variety, however, requires integration if the final result is to become a workable application of the multimedia process. In other words, the various sources of media types must be integrated into a single, cohesive system. According to Williams and Blair (1992), multimedia enables end users to share the various forms of information in an integrated manner.

A. STATE OF THE INDUSTRY

Today's end user faces one of two problems: he must face either the dilemma of information overload or that of information starvation. He has either too much detailed information or he lacks the proper information at the time it is needed. The information services industry has recognized this problem and is attempting to find solutions. (Williams and Blair, 1992)

The integration of the various forms of media into the computer-communications infrastructure provides two key benefits for the end user. First, integration benefits the user by enabling the computer to assist with the management and processing of information. Second, it makes it possible to eliminate numerous

information subsystems, leaving users with a single integrated environment with which to contend. This second benefit is the driving force behind research and development of multimedia information systems. (Williams and Blair, 1992)

1. The Challenge of Multimedia

The optimization of information and communication resources is the greatest challenge that is currently facing the information management industry. Distributed multimedia systems offer a solution to this challenge. The use of such systems, however, raises important design and programming issues. One must always remember that successful multimedia applications are the result of complicated trade-offs among the enabling technologies, various information formats, and specific user requirements. (Vervest and Sherwood-Roberts, 1994)

Albert Lill, from The Gartner Group, recognized the difficulties facing the multimedia market. He points out that the criteria for success is always changing. Experiencing some of the frustration of the market, he also realized that the search for a single "killer application" in multimedia was fruitless. (*The Computer Conference Analysis Newsletter*, 1994)

While multimedia in itself creates some interesting challenges, placing multimedia applications on a network complicates the situation even more. Robert J. Frankenberg, President and Chief Executive Officer of Novell, Inc. says that the corporate world has already recognized the value of the network. (*Edge: Work-Group Computing Report*, 1994)

There are other technical challenges that must be overcome. Among them are the establishment of sufficient bandwidth capabilities for data transmission, the storage and switching of digital signals, interoperability among digitally compatible networks, affordable data compression/decompression processes, and the development of efficient and affordable user devices (*The Computer Conference Analysis Newsletter*, 1994). Of these difficulties, the key performance-limiting challenge is bandwidth. Full-motion color video is especially demanding. Interactivity, an essential element of multimedia systems, must also be considered. (Libincott, 1990)

Standardization is the key that will open the doors to widespread use of multimedia on distributed systems (*The Computer conference Analysis Newsletter*, 1994). Open Network Provisioning (ONP) concepts are transforming the traditional network model (Van Landegem et al, 1994).

Security, privacy, and scale requirements on networks are also major concerns. Solutions to these requirements must be found before distributed multimedia systems become a staple in corporate and government circles. (Gates, 1993)

2. Players

The information industry has accepted the fact that its challenge lies in the hardware, software, and delivery, while content will be the responsibility of the entertainment industry (*The Computer Conference Analysis Newsletter*, 1994). Other players in the multimedia revolution include:

a. Regulators

Industry regulators are dedicated to the concept of fair and equal competition. They expect that this competition will bring telecommunication services into widespread use throughout the country (Van Landegem et al, 1994).

b. Content Owners

As the importance of access to quality content becomes evident, content owners are becoming the center of interest for other market players. While the efficiency of bringing quality products to the home or office workstation is certainly a key element in system dynamics, it is the products themselves that will attract users to multimedia applications (de Boisseson, 1994).

c. Data Processing and Consumer Industries

Data processing and consumer industries are focused on new market opportunities. As the distributed multimedia industry is being formed, competition for market share is at its highest. New and innovative solutions to conventional

problems are daily occurrences. Product evolution, industry alliances, and consumer demands are all manifestations of the dynamic information systems industry (de Boisseson, 1994).

d. Information Distributors

The realm of information distributors is no longer the exclusive territory of telecommunications networks. Thanks to recent technological advances, cable networks, satellite communications networks, and telephone companies are viable players in the battle to distribute information to the ever growing population of potential users. The battle between cable networks and telephone companies promises to be especially interesting (see Table 1). (de Boisseson, 1994)

Table 1. TV/Telephony Comparison. From Noll (1994)

	Television	Telephony
Modality	Video	Voice and Data
Directionality	One-Way	Two-Way
Bandwidth		
Analog	4.5 MHz	4 kHz
Digital	90 Mbps	64 kbs
Compressed	1.5 Mbps	1.2 kbs
Holding Time	Long (hours)	Short (Minutes)
Simultaneity	Many Users	Few Users
Purpose	Entertainment	Information
Network	Broadcast	Switched
Industry	CATV	Telco
Control	Conduit and Content	Conduit Only
Medium		
Today	Coaxial Cable (Copper Wire)	Twisted Pair (Copper Wire)
Future	Fiber and Coaxial	Fiber and Twisted Pair

Until recently, cable operators have been favored to win the information distribution market-share battles. This is due to the advantage of having coaxial cable systems already in place to support the anticipated demand for widespread connectivity. Recent legislation has changed the picture somewhat by providing telephone services with the tools they need to enter the information-distributor arena (de Boisseson, 1994). In order to stay competitive, cable operators are attempting to minimize costs and boost sales by introducing and marketing new services. (Van Landegem et al, 1994)

3. Past and Present Trends

Early surveys of information management trends revealed that, while nearly all users still deal with text-type data, many firms are expressing interest and moving toward multimedia as a standard way of doing business (Kelly, 1994). Technology-based-training (TBT) and point-of-sale (POS)/point-of-information (POI) documentation are on the forefront of applied multimedia processes (Vervest and Sherwood-Roberts, 1994).

While the business sector has shown the greatest growth potential to date, the consumer market is starting to blossom. Inexpensive, yet powerful desktop computers and quicker CD drives are largely responsible for the growing consumer interest in multimedia. Interactive games and educational programs are the biggest draws in multimedia home computing. (*The Computer Conference Analysis Newsletter*, 1994)

Technology, in general, is evolving at an astonishing rate. Improvements in digitization, compression, software tools, and optical components, all accompanied by dramatic price reductions, have effected the feasibility of widespread distributed multimedia systems (de Boisseson, 1994). Full-screened color video from network servers, a service that eats bandwidth at a truly prodigious pace, still challenges distributed computing systems. Technological advances in video servers and video server software products, such as video compression and delivery over Ethernet, Token Ring, and fiber, are quickly bringing this problem under control. (*THE Journal*, 1994)

4. Hardware

Technology has reached a point that enables just about any contemporary computer to process text and produce basic sounds. Graphics are also a normal output for most computers. Animation, which is essentially high-performance graphics, is a limiting factor for low-end computers. High-quality audio emphasizes differences among systems even more. Video, the most demanding multimedia format, is the true test for high-end multimedia computers. Another point of differentiation is in the ability to integrate all of the applicable elements. It takes a truly remarkable machine to fully integrate text, graphics, audio, and video so that the final product is a smoothly flowing presentation. (Robinson, 1990)

Moving from the stand-alone system to networks, it quickly becomes obvious that most of the difficulties lay in data transfer. Wiring, or rather the limitations presented by various grades of wiring, holds center attention. Fiber, with its great bandwidth capabilities and quick speed, is considered the best choice by many computer specialists. Unfortunately, it is also expensive. Asymmetric high speed digital subscriber loop (ADSL) techniques and cell relay transmission methods offer options in the tradeoff between expense and efficiency. (*THE Journal*, 1994)

B. DISTRIBUTED MULTIMEDIA TECHNOLOGY

Information technology has followed a logical progression in terms of processing capabilities. At the beginning of the Information Age computer systems dealt exclusively with numerical calculations. Text processing soon followed, and later the integration of "scientific computers," those that dealt with numbers, with "clerical computers," those that worked exclusively with text, became a reality. The telecommunications technologies, which were following a parallel development course, were adapted to support the transmission of textual and numerical data (Williams and Blair, 1992).

Later computer developments saw the integration of graphics into computer technology. There has also been progress in audio and video capabilities. Researchers are presently working on new technologies that will totally immerse the user with a variety of media output. (Williams and Blair, 1992)

Distributed multimedia computing has, until quite recently, been limited by the lack of suitable communications technology. With advances in telecommunications, however, this roadblock has been overcome. Sufficient levels of bandwidth now make it possible to place multimedia applications on distributed systems. With the advent of distributed multimedia technology comes the potential to create new application areas and to augment those applications that already exist. (Williams and Blair, 1992)

A variety of technological advancements support the development of multimedia compatible networks. Powerful workstations and new storage technology have had a tremendous impact on information processing techniques. The offshoot of these developments is the creation of new applications that were previously not feasible. (Karmouch, 1993)

The continuing evolution of distributed system configurations is opening new opportunities in distributed multimedia systems. Geographical barriers have been removed. Powerful workstations can now share resources by communicating through area networks, thus strengthening inter- and intra-organizational bonds. (Karmouch, 1993)

Technical advancements have given network users the ability to directly manipulate the various types of information media. These media types can now be integrated into a single entity known as the multimedia document. Unfortunately, these documents require faster networks for transmission, high-performance processing, and storage. (Karmouch, 1993)

Perhaps the most difficult technological obstacle to overcome has been the high bandwidth and data transmission rate requirements. Optical fiber and ADSL technologies are quickly overcoming this limitation. The new high-speed networks

enable the transfer of large amounts of multimedia information. Improved transmission techniques are also solving integration and synchronization problems. (Karmouch, 1993)

Groupware technology has brought vast improvements to the way in which people interact with computers and other users. Shared space techniques, an outgrowth of groupware technology, enables two or more participants to view and manipulate common information on their screens. A typical shared space conference will enable the partners to use voice communication while annotating a data display, either on screen or on an electronic whiteboard. Additional data can be accessed by any participant at any time during the conference session. (Karmouch, 1993)

Due to the unique electronic characteristics of each type of media, synchronization is a critical part of the multimedia system. Recent improvements in temporal retrieval procedures, however, have eliminated most problems related to media synchronization. (Poggio et al, 1985)

Not all of the problems associated with distributed multimedia computing have been resolved. Both technical and non-technical difficulties persist. Non-commitment from the commercial sector, the requirement for high performance experimental networks, unresolved digital complications, and the tendency for real solutions to evolve from bottom-up development practices are some of the primary bottlenecks that must be removed before widespread use of distributed multimedia systems becomes a reality. (Williams and Blair, 1992)

C. FUTURE TRENDS

Current multimedia systems employ capabilities that add interactive digital audio and video to the text and graphic capabilities that are common to most desktop systems. The storage capacity of CD-ROM has been tapped to support multimedia on these systems. As desktop computer technology is making quantum leaps forward, multimedia systems are evolving into more complex forms. More efficient programming, more powerful desktop computers, and an array of advanced

peripherals are providing the desktop user with multimedia options. In a parallel movement, the business sector is turning to servers and distribution systems that have been engineered to provide new levels of multimedia support. In the future, multimedia will continue benefitting from an expanding suite of capabilities. (Libincott, 1990)

These technological advancements will spur user demands for increased interaction with their applications. The industry's response to these demands could change the definition of multimedia. Multimedia tools, such as panoramic pictures, interactive movies, and 3-D models, are being developed to support attempts to keep abreast of user demand (Lennon and Maurer, 1994).

Interest in multimedia systems by industry players is driven by that of the users. Fierce competition and novel alliances are being formed and broken as telephone companies, cable television networks, computer hardware and software manufacturers, and information providers vie for market share of multimedia-based information and services. (*THE Journal*, 1994)

1. Current Functionality

In order to provide the expected functionality of distributed multimedia systems, a rich blend of text, graphics, pictures, audio, and video is required. All of these diverse types of media must be integrated into a seamless unit before the multimedia application can be used. Achieving the high degree of interaction between media types needed for the integration is the challenge to multimedia of the 90's. (Lennon and Maurer, 1994)

Of the many benefits that distributed multimedia systems are anticipated to make, improvements in communication technologies are expected to be the most significant. Improvements in both efficiency and effectiveness are expected when users become adept at multimedia techniques. (Vervest and Sherwood-Roberts, 1994)

The positive impact that multimedia can make on training and education has already been demonstrated. Considerable expense has been saved by simply opening the possibilities of distance learning and videoteletraining (VTT) techniques.

Businesses, both large and small, are no longer required to send their people to centralized locations at specific times in order to obtain needed training. The training can now come to the business at the time and place of its choosing. (Vervest and Sherwood-Roberts, 1994)

Technology-based training (TBT) is another area in which multimedia is having a significant impact. TBT applications include everything from basic introductory training, through technical, procedural, and systems training. The use of multimedia in such areas as product knowledge and interpersonal skills have been exceptionally successful. One of the most well recognized form of TBT is the use of flight simulators when training both civilian and military aircrew members. (Vervest and Sherwood-Roberts, 1994)

The use of three-dimensional (3-D) models for training purposes is one of the earlier applications of multimedia. While 3-D models are normally associated with virtual reality, the idea of the user decked out in state-of-the-art helmets and data gloves while manipulating his virtual world is not the principal use of 3-D modeling in a training environment. Real benefits will arise from 3-D animated programs that model real world situations. This scenario can provide a total-immersion learning environment in which the user can practice skills needed for the performance of his work. (Lennon and Maurer)

Faster information access is another benefit of multimedia systems. The wide variety of media that intelligent documentation systems can employ provides alternate ways of accessing data. An exciting new development in this field is the mimicking of the human brain's intuitive relational method of storing and accessing information. (Vervest and Sherwood-Roberts, 1994)

Complimenting the faster information access, distributed multimedia systems often exhibit speedier corporate response times. This increase in response speed is the result of the sharing of information across different users of the network.

Improvements in marketing functions is yet another of the major anticipated benefits from multimedia systems. Point-of-Sale (POS) and Point-of-Information

(POI) applications are already assuming a wide range of uses. Tourist information systems, electronic shopping, and sophisticated information kiosks are all examples of multimedia marketing applications. This is an area that is growing rapidly. The competitive and commercial benefits that those companies that have already invested in these systems is encouraging other businesses to join the multimedia marketing movement. (Vervest and Sherwood-Roberts, 1994)

2. Near-Term Future

Where are we going from here? While precise details are very hard to guess, it is safe to say that today's trends will continue. Users and their equipment will be able to exchange information in a simple, reliable, secure, and cost-effective manner. This exchange can take place at any time and in any place. (Van Landegem et al, 1994)

An interesting potential benefit of the widespread use of electronic communications techniques is the reduction of personnel transport requirements. A ten to twenty percent replacement of transport by teleconferencing, teleshopping, teleworking, and electronic document interchange would have dramatic results. In the United States alone as much as 18 billion ECU could be saved. That is 12 billion ECU more than the world-wide annual savings yielded by the use of alternative fuels. (Van Landegem et al, 1994)

A second benefit that will be brought by more widespread use of electronic communication is increased productivity. This is estimated at anywhere from five to forty percent, depending on the functions for which the communication techniques are used. (Van Landegem et al, 1994)

Future demand for image transmission will be much greater than it is now. It is estimated that home video services will show the most growth over the next ten years. Digital film on demand, a service for which potential vendors are already queuing-up, is expected to experience significant demand growth. Both normal quality and high-definition television (HDTV) will be available. At one to two Mbps and 15 to 20 Mbps, respectively, the demand on data transmission by the two

technologies will be significant. There will also be a need for improvement in memory media such as hard disks and CD-ROM to support the video-on-demand requirements. In the business sector, the cost-saving advantages of videoconferencing will popularize that form of electronic communication. (Van Landegem et al, 1994)

We are now seeing the beginnings of what, ten years from now, should be a flourishing technology. The desktop multimedia system gives the user the flexibility of a multi-functional instrument at the convenience of his desk. Most importantly, the desktop will serve a user interface device to future networks. It will support a number of applications such as phone, video phone, and telefax. Increasingly personalized and customized telecommunication network services will push the limits of custom telecommunication services. Eventually the desktop multimedia system may even emulate the Virtual Private Network (VPN). (Van Landegem et al, 1994)

Wireless communication is also riding the wave toward the future. The Universal Mobile Telecommunication System (UMTS) will support a drive toward increased mobility. It aims at nothing less than the integration of such mobile systems as Digital European Cordless Telephone (DECT), Global System for Mobile Communications (GSM), and Personal Communication Service (PCS). By 2005 truly universal satellite coverage will support the integrated mobile systems, thus providing a global communication network. (Van Landegem et al, 1994)

Distributed processing will definitely play a role in information technology in the future. The demand is being fed by a push toward increased processing power and a shift from large mainframe computers to PCs. Fiber Distributed Data Interface (FDDI) networks, running at 100 Mbps, and Asynchronous Transfer Mode (ATM) LANs, running at 50 Mbps to 2.5 Gbps, may very well be the successors to today's Token Ring and Ethernet LANs. (Van Landegem et al, 1994)

With the growing popularity of global corporations and their widely scattered subsidiaries, there will be an increasing need for massive information exchange. Within the next decade global networks will shuffle vast quantities of information

between widely disbursed workstations. Techniques that are capable of responding to vast transfer demands will play increasingly central roles in business environments. (Van Landegem et al, 1994)

Whatever transfer technique is chosen, it will be required to contend with dynamic bandwidth and traffic demands. It must be able to provide high speed data transfer for both business and home users. Mobility is another highly coveted characteristic of future information systems. It must be supported by the transfer technique. The user with universal mobility will be able to communicate from any location to any person at any time in a simple and secure manner. (Van Landegem et al, 1994)

It is interesting to watch the various players in the communications industry vie for their piece of the information revolution. The direction that information technology will take in the next ten years depends on the results of today's competition.

When asked what form tomorrow's computers will take, Microsoft's William Gates (1993) said that what he terms as the "TV/PC" will be common-place in the near-term future. Neither a television nor a computer, the TV/PC will assume aspects of both. It will be relatively inexpensive, easy to use, and can be placed in the living room as a piece of furniture, much like today's televisions. But unlike the television, the TV/PC has been loaded with chips that are powerful enough to eclipse those of today's PCs. By simply adding a keyboard, printer, and other peripherals of the user's choice, PC-like functionality can be attained. (Gates, 1993)

John Sculley, former Chairman of Apple Corporation, compares the impact multimedia is having in the 1990's with that which personal computing had in the 1980's. Other information specialists concur. Rob Libincott, the business development director of Lotus Corporation, thinks that multimedia is a force of change with incredible power. William Gates of Microsoft says simply that "Multimedia will be bigger than anything else we do today." (Vervest and Sherwood-Roberts, 1994)

It is clear that multimedia has become a tool that is changing the way people learn and work. The reason why it is becoming such an important computing and telecommunications development is that it addresses the increasing need of organizations and individuals to make more effective use of information (Vervest and Sherwood-Roberts, 1994).

III. MULTIMEDIA APPLICATIONS

John Sculley has said that "Multimedia will change the world in the 1990s as personal computing did in the 1980s." Other information industry giants, such as William Gates and Lotus director Rob Libincott readily agree (Vervest and Sherwood-Roberts, 1994). Even though the decade is only half completed, the prediction is well on its way to becoming a reality.

Due in part to the importance for organizations to make better use of their information and communication resources, multimedia is quickly permeating virtually every area of computing. Its ability to combine the power of the computer with that of video, audio, graphics, and text make it an exceptionally helpful tool to harness the tremendous magnitude of information that is available to the average organization. (Vervest and Sherwood-Roberts, 1994)

This chapter looks at four areas in which multimedia is likely to play a large role. These areas are teleconferencing, multimedia messaging, interactive video, and virtual reality. While this is certainly not an all-inclusive list, these four broad areas are having a tremendous impact on the information management industry.

A. TELECONFERENCING

The term "teleconferencing" covers a wide range of technology. A simple telephone conversation between two individuals can, in the broadest of interpretations, be considered teleconferencing (Hayhoe, 1993). At the other end of the spectrum two-way video, two-way audio, and shared data link multiple parties together. At these levels teleconferencing becomes so complex that it functions as a multimedia network. (*THE Journal*, April 1994)

1. Benefits

The primary benefits of teleconferencing are gains in productivity and cost savings. Advances in teleconferencing technology have brought cost reductions

(Leonard, 1992). It is now less expensive and more efficient to hold electronic meetings than it is to send workgroup members to conventional meetings at remote locations. Other benefits include improved business relations, heightened levels of customer support, and opportunities to promote the organization through public relations activities. (*Computer Letter*, November 1993)

Business organizations have been quick to capitalize on benefits gained from the adoption of teleconferencing. Most of these gains are realized in the form of enhanced services and products. They use teleconferencing to compensate for peak and slow periods, for internal coordination as well as coordination between suppliers and customers, for cutting expenses, and for higher visibility to customer and supplier alike. Cuts in travel costs and faster, more effective communications are two of the more obvious benefits. Additionally, the more effective communications that teleconferencing promotes has, in many cases, lead to innovative products and services. (Clemons and McFarlan, 1986)

Perhaps one of the more promising uses of teleconferencing is its role in interactive training programs. The military services have been pioneering in this field since its inception. Today many large corporations are now beginning to follow the Department of Defense's (DoD) lead. One of the more ambitious projects is an attempt by the state of Iowa to introduce interactive training on a state-wide level (Kantrowitz and Nina, 1994). The value of presenting training programs to geographically dispersed participants is just beginning to be realized (Sheridan, 1992).

Teleconferencing is only one means of dispersing information. Electronic mail and computer bulletin boards are examples of alternate dispersion methods. Teleconferencing, however, holds an advantage because it has a superior capability for dialogue and, in the case of videoconferencing, its capacity to convey facial expressions, body language, and tone of voice (*Computer Letter*, November 1993).

2. Levels of Teleconferencing

When the various capabilities of teleconferencing are considered, it becomes clear that there are a variety of levels upon which teleconferencing may be defined. These levels can be described as document conferencing, audioconferencing, videoconferencing. (*THE Journal*, April 1994), and televirtuality (Gale, 1993)

a. Document Conferencing

"Document conferencing" is a term that refers to the use of shared data on common documents by remotely located participants. The use of electronic whiteboards and modems for passing documents among the participants are alternatives to the use of the more traditional facsimile machines. The manner in which the documents are transferred, manually or electronically, is not relevant to the definition. What is important is that common documents are shared among two or more remote locations. (Garland and Rowell, 1994)

Modems transfer files from one location to others, giving all participants a chance to view and modify information as needed. Electronic whiteboards improve on the document sharing process by enabling remotely located personnel to interactively work together, jointly manipulating the data. (Garland and Rowell, 1994)

b. Audioconferencing

The next type of teleconferencing is audioconferencing. It is a versatile and affordable communications tool that uses document sharing techniques and audio transmission to disperse information (Kirvan, 1993). The audio signals may be either one-way or two-way (*THE Journal*, April 1994).

The lack of visual communication between participants hampers the effectiveness of the audioconference. Shared documents help overcome much of the deficiency (*THE Journal*, April 1994). The shared documents and visual supplements, when viewed simultaneously at all locations, greatly enhance the audioconference. Supplements may include videotapes, 35mm slides, overhead transparencies, audience handouts, and computer-based visuals. (Hayhoe, 1993)

The American Bar Association (ABA) is an example of an organization that successfully uses audioconferencing technology. They use a full duplex, two-way voice communication system that runs over normal telephone lines. The system provides a clear sound: with no echoes, clipping, or noisy interference. The ABA audioconferencing system serves the more than 600 employees at their national headquarters in Chicago. Conferencing calls are made on a daily basis to members located throughout the United States. (*Managing Office Technology*, 1994)

c. Videoconferencing

Videoconferencing adds a new dimension to teleconferencing. It is designed to be used by workgroups to improve productivity, reduce business travel, and speed decision making (Yager, 1993). To do this, videoconferencing integrates the technologies of the telephone, television, personal computer, and facsimile machine (Johnson, 1993) (*THE Journal*, April 1994).

The considerable investment that this technology normally requires is normally recovered in a surprisingly short term through productivity advancements and savings in airfare and travel time. Many companies have found a market to rent their videoconferencing facilities, thereby speeding up their return on investment. Still other companies donate its use to charitable organizations for the community good will. (Hayhoe, 1993)

One successful adaptation of videoconferencing is teledemocracy. It uses videoconferencing methods to promote interaction between voters and state legislatures. Weintraub (1993) sees this trend as a throwback to earlier, simpler times when there was a direct connection of legislatures to voters.

Alaska, with its vast stretches of impassible land, pioneered statewide teledemocracy. To date, more than 26,000 Alaskans have participated in programs. Nevada has also experimented with teledemocracy. The State linked hearing rooms in Carson City with workgroups in Las Vegas, thereby saving time and money. (Weintraub, 1993)

Senator Torres, a Los Angeles Democrat, has lead the fight to link the Californian citizen to the California State government. After a particularly eventful committee meeting in which 17 people were able to talk directly to the committee, Senator Torres said, "For the first time, the public is participating in the drafting of legislation."

While many states are starting to provide at least partial coverage in legislative actions, gavel-to-gavel legislative coverage is currently used by five states: California, Minnesota, Massachusetts, Nebraska, and Rhode Island. Cost is the biggest drawback to full legislative coverage. Two states, New York and Oregon, tried it but were forced to quit due to the expense. This trend may change, however, as the cost of equipment and carrier charges drop. (Weintraub, 1993)

Another example of videoconferencing in the government is the three-month test of National Association of Counties (NACo). This was a joint venture between NACo, Bell Atlantic, and Commtel Communications Corporation. It uses VideoTelecom's MultiMax video teleconferencing equipment. Two side-by-side high-resolution color monitors, each linked to its own camera, are used to overcome the "talking head" syndrome that makes so many people dislike the use of teleconferencing. One monitor features control of cameras with zoom and pan capability, giving viewers a feeling of the entire room rather than a small portion of it. The second monitor displays interactive graphics, thus enabling the sharing of charts, drawings, slides, and data among the various participants. (Johnson, 1993)

d. Televirtuality

Televirtuality takes remote conferencing to the cutting edge of technology. Still in the developmental phase, televirtuality combines virtual reality and teleconferencing, thus producing the ultimate solution to distance communications. It enables participants to take that last step through the looking glass; they stop viewing each other on their monitors and start sharing virtual space. This makes it possible for two or more people in different geographical locations to work together as if they were in the same physical location. (Gale, 1993)

3. Desktop Conferencing

If any one innovation can be said to open the possibilities of videoconferencing to the masses, it would be desktop videoconferencing (Schroeder, 1994b). Plunging procurement prices and transmission costs have opened the entire teleconferencing industry for expansion. Desktop videoconferencing, an outgrowth of that expansion, has brought remote conferencing to the worker level (Wildstrom, 1994).

Faster desktop PC's, increased network and communications bandwidth, and more-capable digital video components have spurred growth in the desktop conferencing market. All of a sudden videoconferencing, at prices as low as $200 per work station (Wildstrom, 1994), is in the realm of possibility to even the smallest organizations (Garland and Rowell, 1994).

There are still barriers that must be overcome before there is a widespread adoption of desktop video. Network infrastructure is probably the biggest of these barriers. The connection to the desktop, whether a telephone line or an Ethernet link, is still too narrow for the full-motion, full-screen picture most people would prefer. (*Computer Letter*, November 1993)

Desktop conferencing is just now beginning the long climb from the pilot stage to common corporate use. Multipoint support, application sharing, and support of the H.320 standard for videoconferencing interoperability are needed before desktop conferencing will be ready for mainstream use (Schroeder, 1994b).

Transmission cost reduction can be attributed to innovative systems like AT&T's WorldWorx. It is a video dial tone service that enables business users to conduct videoconferences and exchange data in real time. Designed to ensure interoperability, both specialized video equipment and desktop computers can take advantage of this system. (Wexler, 1994b)

The good news is that WorldWorx transmission costs range from $.50 to 1.50 per minute (Wexler, 1994b). The next version of the software is expected to offer

multipoint collaboration, enabling two to 22 stations to take part in a videoconferencing session. The service will also include data transfer and application sharing. (Garland and Rowell, 1994)

Traders at the Chase Manhattan Bank have already successfully implemented desktop conferencing. Crucial to the traders' job is a fast, accurate exchange of information among themselves. Prior to implementation of the conferencing system, they would have the choice of fighting the tremendous noise levels of the exchange floor or walking over to other traders, thereby leaving their own station unattended for the duration of the conference. The decision to set-up on-screen conference capabilities has reduced much of the communication problem. (*Economist*, 1994b)

4. Teleconferencing Over LANs and WANs

Teleconferencing over LANs presents some problems that are unique to the LAN environment. The unpredictable and "bursty" nature of data transmission on LANs makes it difficult to retain smooth audio and video signals while avoiding unacceptable delays. Even though LANs have sufficient bandwidth, the unpredictable nature of data transmission over shared-media networks make the transmission of audio and video data difficult. Dependable isochronous bandwidth is much better suited for such transmissions. (Garland and Rowell, 1994)

Other problems include the use proprietary codecs in LANs, thereby preventing interoperability, and the lack of standards for LAN-based videoconferencing. This second problem is an extreme hindrance to future development. Efforts, however, are being made to correct the difficulty. International Telecommunications Union-Telecommunications Standards Section (ITU-T) LAN videoconferencing standards are under development, as well as an Institute of Electrical and Electronic Engineers (IEEE) standard for isochronous Ethernet. Until some of the problems associated with these standards get worked-out, Integrated Services Digital Network (ISDN) is still the medium of choice for long-distance computing. (Garland and Rowell, 1994)

The adoption of ISDN played a significant role in enabling multimedia to be placed on desktop computers. ISDN is a high-performance digital communications line that allows up to 64 kbps to be passed. This tremendous capacity comes at the sacrifice of cost. ISDN line charges account for as much as one third of the cost of such systems. (*Computer Letter*, November 1993) ISDN integrates data, voice, and video signals into a digital signal. In so doing, ISDN brings digital services all the way to the home or office and standardizes services provided to the subscriber. (Sheldon, 1994)

Asynchronous Transfer Mode (ATM) holds much promise for the future of LAN-based videoconferencing. With speeds that range from 45 Mbps to over 2.5 Gbps, ATM has the capacity to solve problems involving bandwidth and standardization. It not only has the necessary speed to handle videoconferences, but it also has plenty of bandwidth left over for other operations. Another advantage of ATM is that it will span from LAN to WAN, including communications service providers. This raises the possibility of developing videoconference standards that work at all levels. (Garland and Rowell, 1994)

5. Limitations

Over the past few years there has been a tremendous improvement in teleconferencing technologies. The jerky video, bulky hardware suites, slow transmission speeds, and high cost that have been insurmountable obstacles in the past are now being solved with advanced technology. Now questions tend to focus on matching applications to the right system. (*THE Journal*, April 1994)

Until recently, cost has prevented most organizations from adapting teleconferencing as an integral business practice. The cost of equipping a conference room with video, audio, and document sharing equipment was $50,000 or more. Charges for a coast-to-coast leased T1 line capable of handling the bandwidth needed for high-quality, two-way video was about $20,000 per month. (*Computer Letter*,

November 1993) Now, with desktop video available at around $2,000 per workstation (Wildstrom, 1994) and carrier costs running at $1.50 or less per minute (Wexler, 1994b), even the smallest organizations can afford videoconferencing.

What is perhaps the most annoying limitation of teleconferencing is malfunction of the communication system. As with any highly complex system, problems can arise that hinder, and even prevent, continuing operations. The trend has been towards more reliable, user-friendly operations. While the frequency of system malfunction has been greatly decreased over the past few years, the problem persists and is not likely to be entirely eliminated in the foreseeable future. (Lowengard, 1992)

There are a number of other problems that are common in teleconferencing environments. The limited ability of teleconferencing to relay feedback based on body language and the loss of personal proximity that is present in personal meetings are two of these problems (Lowengard, 1992). Another common complaint about conventional videoconferencing is the lack of eye contact (Gale, 1993). The lack of audience participation capabilities and the risk of loosing workgroup privacy are other limitations (Lowengard, 1992).

6. Developments

Teleconferencing provides an effective means for people to solve practical communications problems. It does this by enabling them to exchange useful information in a manner that saves time and money. This meeting of real needs is the reason for the explosive growth in teleconferencing. (Johnson, 1993)

The potential benefits, however, do not come without risk. As teleconferencing concepts become more widespread, some organizations will embrace the advanced form of communications while others will be overcome by the resulting changes in business practices. (Clemons and McFarlan, 1986)

Personal Technology Research estimates that sales of videoconferencing equipment is expected to rise from $660 million in 1993 to $10.8 billion in 1997.

The driving force behind this boom is cheaper technology. With desktop workstations costing less than $2,000 per station, the growth in teleconferencing is expected to progress at unprecedented rates. (Blackwood, 1994)

The wider availability of switched data systems, a much less expensive way of maintaining communication, is also contributing to the phenomenal growth in the teleconferencing industry. With these cost saving methods in place, many organizations are turning towards teleconferencing rather than conventional meetings. (Blackwood, 1994)

When all is said and done, however, the real benefits to teleconferencing are increased productivity and faster decision-making. Time lost due to travel requirements and the ability to include more employees in the meetings, rather than the limited few who the organization can spare for remote meetings, round out the list of advantages that make teleconferencing one of the fastest growing applications of the 90's. (Blackwood, 1994)

B. MULTIMEDIA MESSAGING

Multimedia mail is a service that enables users to exchange electronic documents that contain different types of messages. These types may include text, audio, imagery, and video. Its introduction represents a significant advancement in electronic mail. (Baveco et al, 1994)

Robert Allen, Chairman and CEO of AT&T, summed up the present state of electronic messaging systems by saying, "Currently, communications are targeted toward voice and data, but we're moving toward multimedia" (Schroeder, 1994a). In order for this movement to be realized, however, multimedia messaging system must be flexible enough to support an incredible variety of user requirements. The internal coordination demands of a large company and the need to communicate with outside sources of a smaller company both have to be met if multimedia is to be a successful messaging application. This means that the underlying architecture should allow use as both a private and a public service. (Baveco et al, 1994)

1. Types of Messaging Systems

Electronic mail, voice mail, and facsimile technologies have been the primary electronic communication methods for the past several years. These technologies are now beginning to merge into single systems, thus blurring the distinction between the three converging technologies. (Valenz, 1994)

Advances are also being made in information retrieval methods. Unified messaging, one of the hottest new topics in communication technology, enables voice mail, electronic mail, facsimile, and graphics to be retrieved from a single mailbox. (Valenz, 1994)

a. Electronic Mail

The mainstay of electronic communication has been electronic mail, commonly referred to as e-mail. It is an asynchronous communication method that enables computer users to communicate with each other. E-mail normally transmits text-only and limited graphics messages. The implementation of the Consultative Committee for International Telegraph and Telephone (CCITT) X.400 series of recommendations is causing this to change. This series supports multiple message bodyparts, enabling the use of the various types of messages. (Moeller et al, 1995)

b. Voice Mail

Voice mail systems, an automated outgrowth of telephone answering devices, are highly rated as a business communication medium. Over the past few years, voice mail has provided the greatest productivity gains of any business communications equipment, surpassing facsimile machines, e-mail, modems, and Private Branch Exchange (PBX) systems. (*EDGE*, 1994b) (Valenz, 1994)

Voice messaging systems are at a critical point in their evolution. Until now, these systems have been regarded as telephone answering devises. That view will change as voice mail becomes integrated with electronic mail and fax at the desktop computing level. The integration will extend the traditional message exchange function to applications that cover many new uses. (Tennant, 1994)

In its original form, voice mail was designed to record, store, and retrieve voice messages. These systems can now do much more. Their new capabilities include networking, real-time interfaces to host databases, multi-functionality, speech recognition, multi-language handling, fax interfaces, and universal messaging. These capabilities will soon be augmented by image processing and multimedia messaging capabilities. (Valenz, 1994) Eventually new features will be added that bring telephone and computer technologies even closer together, making them available on single voice messaging suites (Tennant, 1994).

Eight million people in 40,000 business locations are already connected to voice mail services (*EDGE*, 1994b). Now a simple and effective means of communication, voice mail continues to evolve (Valenz, 1994).

c. Multimedia Mail

Multimedia messaging systems enrich the traditional text exchange by adding imagery, video, and audio capabilities to the more traditional text (Moeller et al, 1995). As the experts begin to recognize the potential of multimedia communications, they are gearing for an explosion of multimedia solutions in the workplace (*EDGE*, 1994b).

There is a price to pay for the use of various message types. Bandwidth requirements for multimedia messages can be phenomenal. Even though advanced compression techniques greatly reduce these bandwidth requirements, a video sequence or high resolution image may still be too large for a message transfer system. Storage capacities at the recipient's site is another problem caused by the potential size of video messages. Store-and-forward message transfer systems add to the problem. (Moeller et al, 1995)

Multimedia messages can be comprised of several units of information, each of which contains data of a specific media type. The media types include text, image, audio, and video (Moeller et al, 1995). A new advantage that some high-end multimedia systems have is the ability to convert messages from one media type to another (*LI Business News*, 1994).

Info System's voice messaging package, Talkie-Mail, is an example of the new multimedia messaging systems that are now finding their way to the market. Talkie-Mail includes an automated attendant, voice mail system, talking classified advertisements, fax-back, fax-broadcast, caller ID, and an interactive voice query. With this mixed-bag of features, the evolution from voice mail to multimedia mail has begun. (*EDGE*, 1994b)

AT&T has also entered the multimedia mail market. Its recently implemented Intuity System combines voice messaging and voice response technology. The end result is an advanced business messaging system that allows people to "hear" a fax and "see" a voice message. (*LI Business News*, 1994)

In an attempt to strengthen its hold on the market, AT&T is adding two features that have much potential. The first is a unified mailbox that will be enhanced to accommodate fax, e-mail, and video capabilities (Wexler, 1994a). The second feature is store-and-forward video support for Video for Windows files (Schroeder, 1994a).

User friendly and accessible both in and away from the office (*LI Business News*, 1994), salespeople are expected to benefit from the Intuity messaging system. It should be particularly effective in customer service relations and marketing, where it can facilitate the delivery of updated market information and allow immediate sales presentations, complete with voice, text, and full motion video. (Kimball, 1994)

d. Active Mail

One of the newest developments in messaging systems is active mail. It enables a message to contain a program that can be executed when the recipient reads it. As would be expected, this ability to transmit working executable commands brings a plethora of security problems with it. Once these problems are brought under control, however, there are some exciting possibilities with active mail. (Freed, 1994)

2. Functionality

There is a lot of commonality among existing electronic mail systems. These common services include such utilities as distribution lists, copy recipients, and delivery notification. The adoption of multimedia mail should, as a minimum, guarantee the same type of services as is found in standard electronic mail systems. (Baveco et al, 1994)

Multimedia mail must be capable of generic operations, such as create, present, submit, list, retrieve, delete, and store (Baveco et al, 1994). To support these operations, it shares a number of general services with other applications (Moeller et al, 1995).

a. Editing and Viewing Services

A multimedia mail service may have many editors and viewers. While the viewer for mail headers must be specific to mail, the editors and viewers for bodyparts can be general external programs. The use of external viewers and editors makes it possible to customize the mail system. (Moeller et al, 1995)

b. Mail Filing Services

A mail filing service is a filing and retrieval system for electronic mail messages. It enables the user to create and file new documents, to present any received documents, and to store such documents (Baveco et al, 1994). The service is usually hierarchically-organized to enhance message search and retrieval. The system places messages into electronic "folders" that are eventually forwarded to user-specific or group-specific cabinets. (Moeller et al, 1995)

The X.400(88) Message Store assists the user by providing him with a continuously available storage mechanism (Moeller et al, 1995). Mapping locally produced documents on an extended version of X.420 enables the user to incorporate new representation types. This supports the concept of distributed documents, a result of hypermedia links and references to remotely located data. The Message Store can be programmed to meet the user's needs. (Baveco et al, 1994)

c. *Global Store Services*

Global Store Server is, in effect, a data management system. It enables the user to store parts of the multimedia mail after submission or retrieval (Baveco et al, 1994). It is ideally suited for multimedia mail because it has the ability to manipulate data without regard to format or encoding. It also supports interactive control of the audiovisual data streams, such as rewind, pause, and slow-motion. (Moeller et al, 1995)

d. *Conversion Services*

The very nature of multimedia applications require the handling of diverse types of medial. One function of conversion services is to support system the do not have the required viewer or editor for a specific bodypart (Moeller et al, 1995). A message containing both speech and text, for example, may be received by a system that does not have speech playback capabilities. Converting the speech portion to text will alleviate this problem. (Pate, 1990)

Media conversion is potentially advantageous for the handicapped. Text can be converted to voice for the blind, and the process can be reversed for the deaf. Going a step further, video clips of sign language can be developed from the text. (Pate, 1990)

3. Standards

Multimedia mail service should be built on open architecture with standardized components if it is to be sufficiently flexible to support truly global networking (Baveco et al, 1994). The push toward standardization is a driving force in multimedia communications and information infrastructure (Mayo, 1994). While the use of ITU-T (formerly CCITT) recommendations and International Organization for Standardization (ISO) standards is suggested (Moeller et al, 1995), a new generation of voice messaging protocols will be needed to enhance the development of multimedia communication (Tennant, 1994).

There is currently no standard that supports multimedia messaging in a heterogeneous environment, but encouraging developments in standardization efforts are beginning to be felt throughout the industry (Baveco et al, 1994).

a. Multipurpose Internet Mail Extension

In order to exchange multimedia messages across heterogeneous systems, a protocol that provides a degree of commonality is needed. The Multipurpose Internet Mail Extension (MIME), RFC 1341, was specifically created to fill just such a void on the Internet. Its success in that environment has been so great that it is rapidly gaining acceptance for use in enterprise networks. (Freed, 1994)

MIME is an open standard that has the flexibility to handle new sub-content types and encoding schemes. Given multimedia communication's fast-changing standards and methods of data representation, this flexibility is essential for continued support of the messaging systems. (Patel et al, 1994)

The value of MIME on networked systems, particularly the Internet, is that it supports different types of e-mail transmissions across heterogeneous computing environments. It is compatible with Simple Mail Transfer Protocol (SMTP), thus allowing e-mail to contain multiple objects and information types. For extremely large transmissions, it can automatically activate a File Transfer Protocol (FTP) server for the retrieval of bulk data transmissions. (Baveco et al, 1994) Perhaps equally valuable, MIME can be retro-fitted to most existing e-mail infrastructures (Freed, 1994).

MIME converts various types of message data - such as multilingual text, images, video, audio, and PostScript files - to seven-bit American Standard Code for Information Interchange (ASCII) format. It uses RFC 822-like headers to describe the type of message and media being encoded and to ensure that they are reassembled correctly at the receiving end. In so doing, it supports a variety of message types as they pass through the Internet links. (Freed, 1994)

MIME represents a significant advance in electronic communication. MIME-capable e-mail systems will spawn other emerging technologies. These

include active mail, which uses e-mail messages to initiate applications, and message bodyparts of various types. It also provides a mechanism for specifying new types. All of this enhances the development of multimedia messaging. (Moeller et al, 1995)

b. *CCITT X.400 Standard*

The interpersonal message is a mechanism that provides the capability of one user to exchange information with another. This interpersonal message has both a heading and a body. The heading consists of a variety of fields, including the originator and the recipients of the message. The message body consists of an arbitrary number of bodyparts, each of which contains data of a specific information type. (Moeller et al, 1995)

The use of existing standards, such as the CCITT X.400 standard, demonstrates an encouraging trend in multimedia messaging developments. Rather than implementing new standards for multimedia mail, requirements can often be met by combining existing standards. Such an approach may yield difficulty in coordination, but the payoff is worth the effort. The resulting communications system is compatible with many existing systems and is flexible enough to support both public and private service. (Baveco et al, 1994)

X.400 is already in use as a support to multimedia messaging in that both voice mail and facsimile are braced by the standard. Its incorporation of an externally defined bodypart is advantageous to its use in multimedia. Unfortunately, the lack of a coordinating mechanism between various information types and problems with the transfer of messages that exceed 2 megabytes are going to have to be solved before X.400 can become a true multimedia messaging standard. (Baveco et al, 1994)

c. *Electronic Data Interchange*

Electronic Data Interchange (EDI) is a collection of standards that governs how data is transferred between stations. Although negotiation and synchronization between the stations is still required, EDI does enable users to exchange a collection of standard message formes on any electronic messaging service. (Wayner, 1994)

4. Limitations

Several key issues are limiting the use of multimedia messaging. These issues include the lack of interoperability of various multimedia messaging products and the cost of those items. (Knight, 1994)

The technology to properly design multimedia messaging systems exists. However, the poor use of the technology often leads to frustration on the part of people who are trying to make contact. Endless menus with no chance of reaching a live person and poorly designed prompts are just two of the manifestations of these problems. (Valenz, 1994)

5. Developments

There is little doubt that networked multimedia communications will have a tremendous impact on the nature of work (Mayo, 1994). Multimedia messaging will bring about an unprecedented change in the way we do business by giving us the ability to electronically communicate anytime, anywhere, and anyway (*EDGE*, 1994b).

When attempting to solve the problem of getting large volumes of diverse data from the source to the receiver, alliances between software vendors and telecommunications firms will proliferate. Oracle Corp and US West, Inc., for example, have formed a joint development agreement to implement wide-scale multimedia messaging services. Novell, Inc. and AT&T have also joined forces. They are developing products that link computer networks and business telephone services. (Moser, 1993)

The use of multimedia messaging is expected to surpass that of real-time communications. Capabilities of future multimedia messaging systems are most promising. Seamlessly working with all types of messages, the user will be able to attach a voice message to an electronic mail message or convert electronic mail to voice mail with equal ease. He will also be able to receive still image and video messages, and retrieve news from an information service tailored to a person's business needs. (*LI Business News*, 1994)

C. INTERACTIVE TELEVISION

Since its inception nearly 50 years ago, broadcast television services have dominated the mass communications market. This is about to change. Within the next ten years, television-service consumers will be able to maintain two-way communication between themselves and the networks. The passive viewer will become the active user, capable of receiving individualized data as well as sending input back to the network. (Calvet et al, 1994)

The concepts of individualized television service and two-way communication are the basic tenets of interactive television (ITV). The potential value of this communications medium is driving the industry to solve the technological difficulties that are presently denying ITV to the masses (see Figure 1). (Chiddix, 1994)

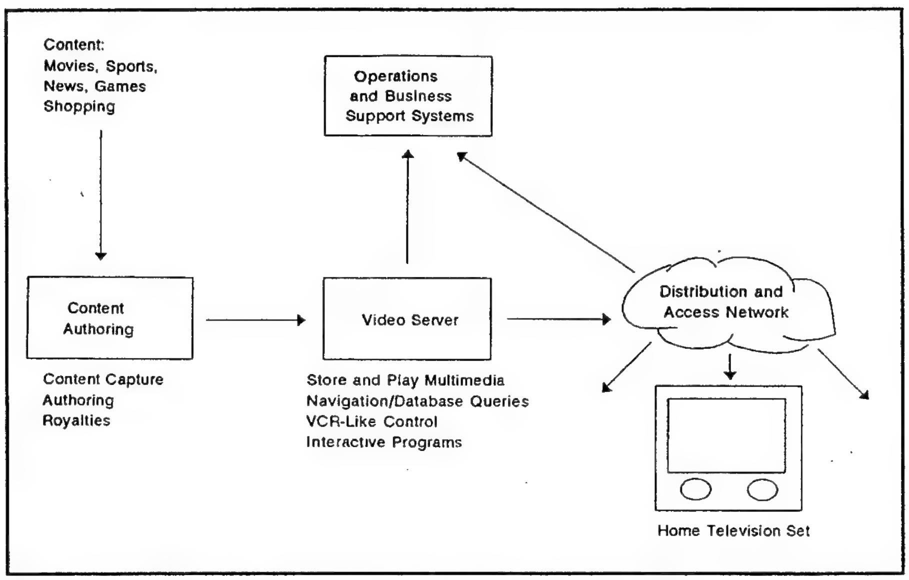

Figure 1. ITV Architecture. From Natarajan (1995)

1. Personal Applications

While interactivity holds much promise, there is also a great amount of uncertainty. The direction of technical advancements is clearly laid out. What is not

clear, however, are future customer specifications. There is no definitive answer to customer demand. In order to forecast future requirements, developers have been searching for "killer applications" - those applications with which the customer will not be able to live without once they have been introduced to the public. (Hudis, 1994)

Developers differ in what they see as the killer application. Bank (1994) has determined that there are five of them: video-on-demand, home shopping, video games, gaming or gambling, and interactive advertising. Bill Broost of the Atlanta based Broadband Communications Group, however, does not agree. He is not convinced that ITV will be available to the masses for many years to come. He thinks the complex technological challenges of ITV will prevent widespread adoption of the idea. For him, consumer online services will be the most popular use of ITV in the near-term future.

Yet another opinion, that of John Colligan, President and CEO of Macromedia, claims that interactive education will be the primary reason for many people to address the ITV challenge (Flynn, 1995). McConnell (1994) agrees that consumers, when surveyed, put interactive education at the top of their priority list. However, he also notes that the most popular interactive applications in tests have consistently been home shopping and games.

a. Video-On-Demand

The video-on-demand (VOD) market will be a most lucrative one. A consulting study indicates that the market will grow $1.3 billion per year by the year 2000. With this incentive, it is no wonder that telephone companies and cable networks alike are lining up to try to cash in on the profits. (Schwartz, 1994)

VOD differs from present-day pay-per-view in that the customer has greater control over the video itself. True VOD requires that movies and television programs be transformed into digital files. These files can then be transmitted to the

viewers' homes via telecommunication networks. The customer selects the time to start viewing and, with VCR-like controls, is able to start, stop, rewind, and fast forward at the time of his choosing. (Schwartz, 1994)

VOD provides its service in units called "streams." A simplistic definition of a stream is flow of data that moves from its starting point to its ending point in one continuous, steady movement. Due to the nature of video and audio data, real-time or near real-time throughput must be achieved. Even brief delays in video or audio data are quiet noticeable to the user. (Chang et al, 1994) (Halfhill, 1994)

Degree of interactivity is the basis for classifying three types of VOD service. The first degree is called Interactive VOD (IVOD). It is a truly interactive mode that uses a switched service technology to provide each user with a unique data stream. In terms of resource requirements, it is the most costly of the three types of VOD. IVOD offers full interactivity and the virtual VCR function. (Chang et al, 1994) (Ciciora, 1995)

Staggered VOD (SVOD) is the next type of VOD service. It generates multiple streams from the same movie at short, regular intervals. These intervals are usually only a few minutes apart. The viewers gain their VCR function by jumping between the various streams that are broadcast to all users (Chang et al, 1994).

The least interactive type of VOD is Near VOD (NVOD). Like SVOD, it is an engineering approximation rather than true VOD. Broadcast movies are stagger-started on multiple channels, but at longer intervals, usually 15 or 30 minutes apart. (Chang et al, 1994) (Ciciora, 1995)

While many developers had hoped that VOD would become a way of life for the masses by the mid-1990's, concerns by prospective service providers have reigned in progress. Faced with significant up-front investment costs, the service providers are understandably cautious. Their emphasis is on trial and analysis, with full implementation efforts to come only after some of the uncertainty has been reduced. (Ratcliffe and Dawson, 1994)

There are a number of ongoing trials in various stages of development, implementation, and analysis. One such trial occurred in Littleton, Colorado. It teamed AT&T, Communications Incorporated, and U.S. West in what was to become the first major alliance between the telephone companies and the cable networks. The results of their cooperative assistance was that the usage rate went up to about 12 times the national average. Other VOD experiments are being done in Orlando, Florida; Castro Valley, California; Washington, DC; and Omaha, Nebraska. (Schwartz, 1994)

There are several problems that must be solved before VOD becomes a widespread service. From the business point-of-view, the biggest problem is that no one knows what the customer wants. How will it stand up against the video rental market? Should the system be integrated or distributed? Billing models, advertising methods, and video content are all questionable factors that need to be settled before the VOD market takes off. (Arnett, 1994)

b. Home Shopping

Future home shopping applications are about as far advanced from today's home shopping channels as video-on-demand is from pay-per-view movies. In the future, the shopper will be able to sift through indexes and choose the merchandise he wants to view. A click of a mouse or a few keystrokes will initiate the purchase. The seller will be able to electronically record all sales, keep demand and inventory records, and track all orders through the system.

The Economist (1994) predicts that, within ten years time, interactive home-based shopping will account for sales of as much as $300 billion per year in this country alone. That figure amounts to about 15 percent of today's annual retail sales of $2.1 trillion. The triple advantages of information, cost, and convenience are the driving forces behind what promises to be a spectacular growth in the industry.

In spite of these impressive figures, there are obstacles to overcome. For instance, only a small percentage of people above the age of 15 feel comfortable in a computing environment. Another problem is the high cost of digital

telecommunications technology. Additionally, when working with financial transactions over a computer network, security is always a problem. Finally, there is the possibility that consumers may not want the service. They may prefer the conventional shopping trip over the electronic one. (*Economist*, 1994a)

Home shopping is being tested in a number of sites. Time Warner, a media company, and US West, a telephone company, have formed an alliance to run on such test. Over 4,000 households in Orlando, Florida are being given an opportunity to experience the convenience of interactive home shopping. Another 1,000 households in Castro Valley, California are also being given a chance to test the electronic shopping waters. Viacom, and AT&T have teamed-up to make this test possible. (*Economist*, 1994a)

c. Video Games

Multiplayer games, three-dimensional animation, and virtual reality settings are bringing video games to new levels. The ability of each player to interact with other players and the video host is heightening interest in the games. Another prospect is the ability to place potential players into skill-level categories, ensuring challenging gamesmanship for all.

A promising emergent form of PC gaming is the interactive movie. It is a hybrid of video game and movie - a computer game, or movie, in which the user plays the leading role. The challenge is to create the illusion of free will while the movie guides the user through the maze that is available in the pre-determined plot. The interactive movie combines live actors, virtual-reality interface, spoken dialogue, cinematic story, and freedom of action for the player. (Goodwin, 1994)

Access Software has opened the interactive movie market with its first release, "Under a Killing Moon." While Access was able to meet most of the technical requirements, there are some problems that need to be overcome before interactive movies become a popular form of entertainment. (Goodwin, 1994)

The greatest difficulty is the mandatory use of the keyboard when talking to or for characters within the movie. The delay in action while the user

either types or selects his lines make the process somewhat ungainly. Another problem is that the ten frames per second (FPS) speed of the movie makes the action somewhat choppy. The choppiness is the result of a trade-off between full-screen video and film speed. Even with these shortcomings, however, Access Software has demonstrated that the future of PC gaming may well lie in the direction of the interactive movie (Goodwin, 1994).

d. Gambling

Another of Bank's (1994) killer applications is interactive gambling. Several airlines, including British Airways and Virgin Atlantic Airways, are testing in-flight gambling. Meanwhile, the Hearst Corporation and Bell Atlantic Corporation are examining the possibilities in television-based interactive home gambling systems. (Viuker, 1994)

The promise of interactive gambling has lead to the creation of Interactive Wagering Network (IWN). IWN was developed by Command Performance and NTN Communications Incorporated. It provides both interactive cable television and transaction processing to the gambling and horse racing industries. Wussler (1994) predicts that interactive gambling will soon be available in 40 states, providing legislative approval is gained.

e. Interactive Advertising

Interactive advertising represents a major change from the advertising to which the American people are used to being subjected. The 30-second image advertisements that concentrate on persuasion have no place in interactive advertising. Instead, it will shift the emphasis from persuasion to information. Potential customers are going to explore the best means of satisfying their own needs through information concerning the products for which they are searching. There should be less of an intrusive marketing style and more of a general store feeling. The potential customer need only look at the type of item in which he is interested. Interactive advertising should be less intensive and more informative than the image advertising to which we are now exposed. (De Groot, 1994b)

Brueckner (1994) cautions that there are five basic rules that advertisers must remember if the full potential of this interactive tool is to be realized. First, the basic differences between broadcast and interactive television must always remain foremost in the minds of the advertisers. Repetition and attitude, effective tools in the broadcast television world, take a back seat to courtesy and value in interactive advertising. Second, customers are looking for information about the products they choose to review. Third, advertisers must concentrate on selling the product, not the hype. Fourth, while graphics can be used to get the consumer's attention, it requires words to sell. Finally, the customer, not the advertiser, dictates the flow and pace of the information.

f. Interactive Education and Training

In spite of the immense profits awaiting voice-on-demand systems, interactive-television technology will first prove itself valuable with education and training programs. While it is the private sector that will gain the most from this type of application, the public demand for personal-improvement programs is bound to effect the interactive television industry. (Knibbe, 1994)

Interactive training's primary advantage is an increased retention rate. Research that was done for IBM highlighted the fact that people remember only about 20 percent of the information they read. That figure rises to 40 percent if they hear the information. Those people who interact with a training system, however, have a retention rate of approximately 80 percent. (De Groot, 1994a)

The other primary advantage to interactive education is that this type of training and education is inherently customized to the user's needs. Employees need go no further than their own PC to access the various sessions. They can move at their own speed and tackle smaller units, rather than being forced to complete entire lessons at a single sitting. (De Groot, 1994a)

The Iowa Communications Network (ICN) has already leaped into the interactive education arena. ICN developed an integrated telecommunication system

that uses both microwave and cable technologies. So far, the system links 105 schools and colleges, three prisons, an armory, and three hospitals. The next stage will bring hundreds more schools, libraries, and state agencies into the system. (Kantrowitz and Biddle, 1994)

ICN has been well received. So far, the biggest problem has been in the concept's success. Demand has outstripped capability, leaving many users with trouble entering the system. The next phase should help to reduce the access problem. (Kantrowitz and Biddle, 1994)

2. Corporate Applications

Interest in corporate use of interactive video is rapidly growing. Even though many potential users still hold the traditional view that video and corporate LANs are not a viable mix, others are working hard to make LANs suitable for video. One problem that this movement is facing is the inherent difficulty in quantifying return on investment. (Hurwicz, 1994)

A typical video-capable LAN will have front-end client applications to provide menus of video titles. Once a title has been selected, a video server will pass the compressed video data to the client. The client will decompress, decode, and display the data as video in a window. The front-end software will give the user VCR-like control over the system. (Hurwicz, 1994)

There are some major obstacles to be overcome before truly video-capable LANs become a reality. Existing PC and network operating system platforms are not designed for video. They cannot supply the huge amount of data that video requires, nor are sufficient amounts of hard disk storage and network bandwidth normally available. If unique video information must be provided on a continuous basis to several users simultaneously, the information requirements are multiplied. This presents some major challenges to the LAN. (Hurwicz, 1994)

Corporate America has already accepted the LAN concept as a cost-effective means of distributing information. The addition of video to this tool will greatly

increase its capabilities. The use of video to communicate with both suppliers and customers will provide added dimensions to business flows. E-mail, training, and information services can all be enhanced with video. (Hurwicz, 1994)

As is always the case with video, bandwidth/data rate and storage requirement obstacles are most difficult to surpass. There are several different schemes that help deal with these problems. Most of the schemes concentrate on the reduction of bandwidth requirements, limiting the number of simultaneous users, dropping video frames, or combinations of these three elements. (Hurwicz, 1994)

3. Interactive Television Infrastructure

The network infrastructure required to support interactive television is faced with the challenge of streaming vast quantities of data to individual users. To accomplish this, a complex system of video servers, switches, and gateways, linked with advanced transport technology, will be required (see Figure 2).

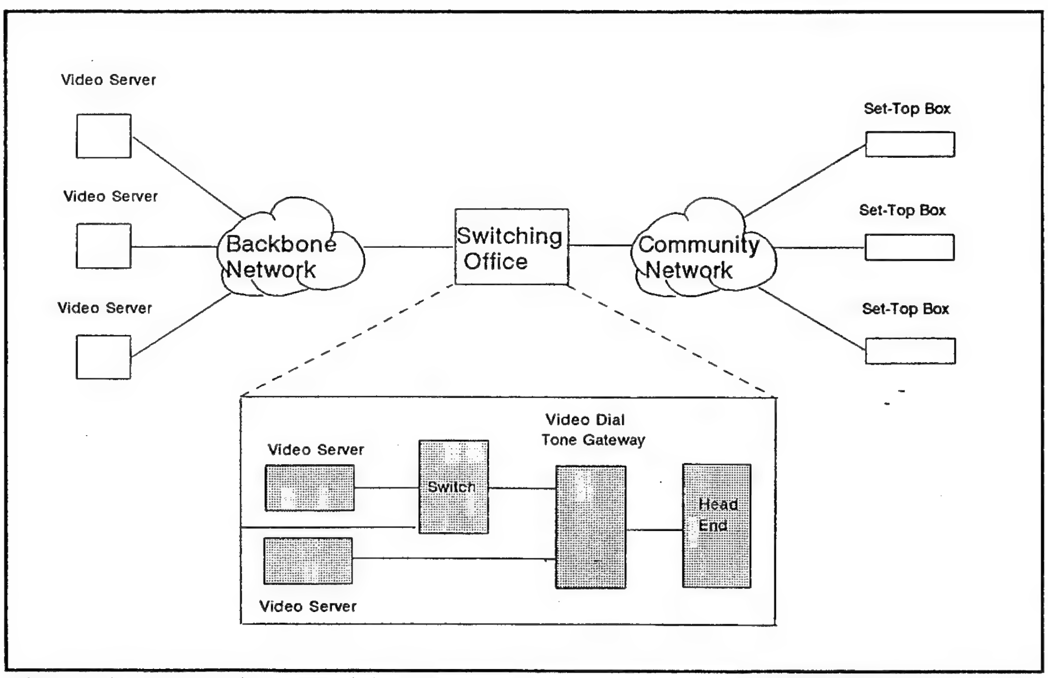

Figure 2. Interactive television network. From Chang et al (1949)

a. Video Server

The video server is a key component of the ITV system. It must store and transmit full-motion video, stereo sound, and other rich data types (see Figure 3) (Halfhill, 1994). The data-intense environment in which it operates pushes the video server to its limits. Output data rate requirements of 400 MB per second are not uncommon. Storage capacity is another great obstacle that needs to be surmounted. At least 1.5 TB of on-line disk capacity and 6 TB of off-line archival tape capacity are required. The output and storage requirements for even a small video server outstrip those of all but the very largest mainframe computer systems. (Natarajan, 1995)

The most likely way of storing the bulk of data is through a system of servers distributed across a hierarchical network. The more popular videos and games will be held on local servers for immediate access to a relatively small group of users. Less popular videos will be stored on more remotely located servers. (Chang et al, 1994)

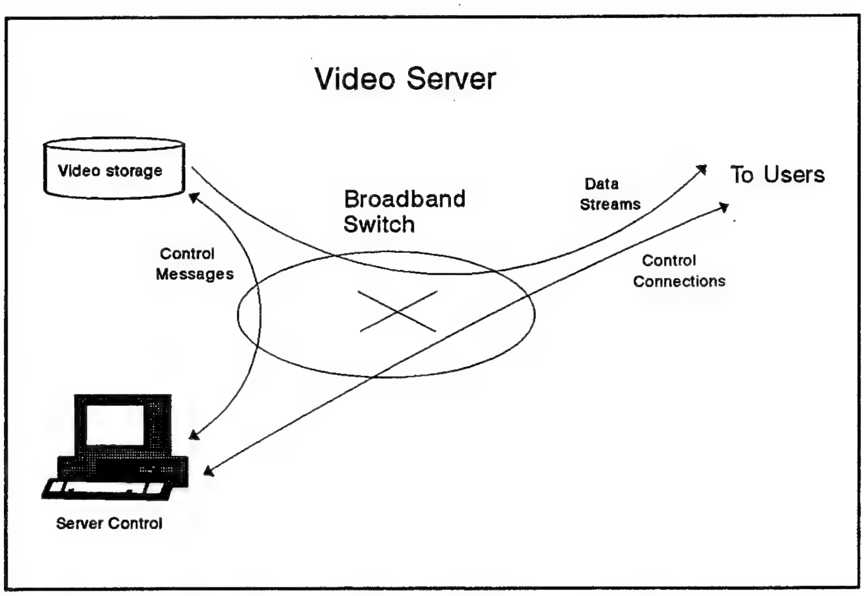

Figure 3. Video Server. From Cavert et al (1994)

The bulk of the stored material, however, will be archived in near-line storage. With vastly more titles than viewers, these videos are the ones that are accessed only sporadically. Direct access to videos in an archive is not practical. The videos will be downloaded at user request and transferred to a local server at speeds far in excess of viewing rates (Chang et al, 1994). Banks of automated jukeboxes that can mount tape cartridges on the video server within seconds of a user's request. The video will then be copied onto its local mass storage for transmission to the user. During transmission the video will be placed in a buffer to ensure continuous streaming of the data. (Halfhill, 1994)

As complex as the storage problem is, the input/output (I/O) requirements are even more difficult. In a metropolitan area the requests for videos could total in the thousands during peak hours. If IVOD is used, its asynchronous nature will require separate streams to almost every user. Virtual VCR functions, which enable the user to interact with the incoming stream, require thousands of file pointers to keep pace with frequently shifting viewing patterns (Halfhill, 1994).

The advantages of programs provided by video servers lie in the VCR-like controls. Programming so delivered can be started and stopped at the user's convenience. It can also be paused, rewound, and fast forwarded as desired. In addition to movies and television programming, home shopping, interactive advertising, and information services are provided by video servers. (Hurwicz, 1994)

From a functional viewpoint, there are a number of ways that video servers differ from database servers. Admission control, request handling, data retrieval, guaranteed stream transmission, and stream encryption are some of the functions that are unique to the video server. The requirement to offer continued support for virtual VCR functions further separates the two types of servers. (Chang et al, 1994) (Natarajan, 1995)

Distribution is only one of the jobs that video servers are tasked to do. They are frequently connected to content-authoring systems, systems that are capable of merging data in video, audio, text, overlay graphics, and other data types. Text

and overlay graphics are generated directly by the authoring system, while audio and video material are digitally encoded into standard formats, such as MPEG (Natarajan, 1995).

Also connected to the video servers are systems that support the operations of an interactive television system. General-purpose computers running applications for billing, subscriber and network management, and functions of that kind are all included in operational support. The input for these support systems is generated by the video server (Natarajan, 1995).

b. Digital Terminal

Another key element in ITV systems is the digital terminal, also called the subscriber terminal or, more commonly, the set-top box. This equipment can, along with the television monitor and the remote control, connect the user to a video server. (Chang et al, 1994) (Ciciora, 1995)

The set-top unit enables the user can manage 500 channels over existing coaxial cable. It bridges the gap between the analog television service of today and tomorrow's interactive digital television service, thereby giving the user an ability to interact with the system. (Barr, 1994)

The digital terminal can be thought of as a specialized computer that contains a powerful microprocessor, such as an Intel 486, PowerPC, or Mips R4000 (Halfhill, 1994). It is used for such tasks as remote control management, user-interface interaction, interfaces to peripheral devices, and protocol exchanges with the Video Dial Tone (VDT) gateway (see Figure 4) (Chang et al, 1994) (Ciciora, 1995).

The main functions of the set-top are demodulation, demultiplexing, and decompression. Elements within the set-top device include a line transceiver, demodulator, decompression unit, back-channel interface, remote control, and display driver. The line transceiver enables the unit to receive incoming signals and to send control information back through the system to the video server. Once the signal is received, the unit demodulates it, decompresses it, and converts the stream to analog form for presentation to the video monitor. (Chang et al, 1994) (Halfhill, 1994)

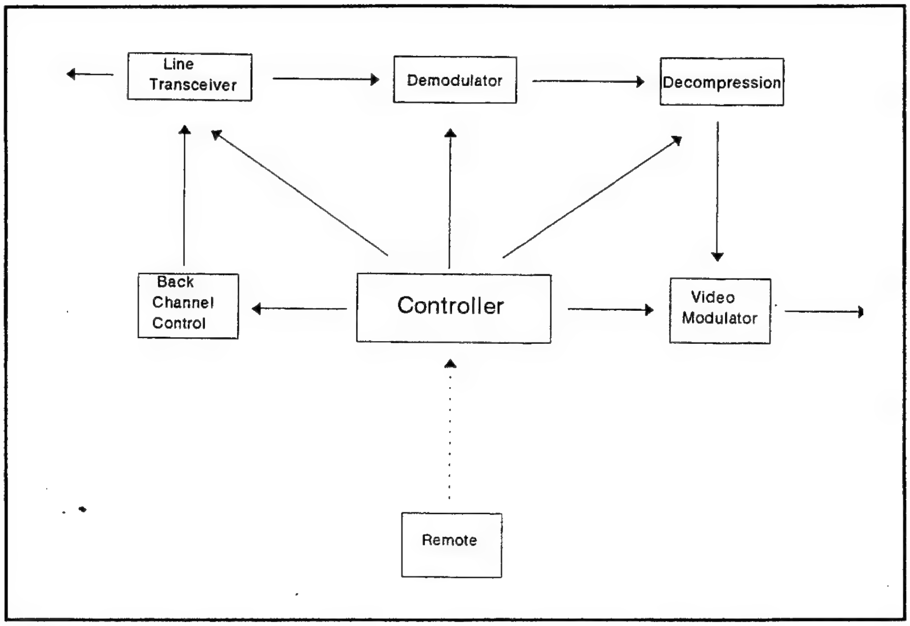

Figure 4. Digital terminal. From Chang et al (1994)

Set-top boxes may also include interfaces to peripheral devices. Printers, infrared receivers and transmitters, telephone lines, high-fidelity audio systems, and VCRs are all examples of peripheral devices that could be linked to the basic ITV system. Such linkages expand the capabilities of the system. (Ciciora, 1995)

The issue of security must be faced. There are two aspects to this issue. First, there is the concern for subscriber privacy, especially if billing services are an element of the session. The second issue concerns the protection of the property owners' rights (Ciciora, 1995). Because ITV is a broadband service, the entire signal band is vulnerable to piracy and breaches of privacy. Access systems use scrambling or encryption to foil attempts of unauthorized access. Each set-top has the facility to generate decryption keys specific to a particular stream. (Chang et al, 1994)

There is a wide variety of possibilities that the set-top box presents to future ITV systems. Prototype studies are using this technology to develop the

systems. There are, however, several difficult and controversial issues that must be settled before the devices can be distributed to the masses. Ownership, interference with other services, security, customer support, obsolescence and innovation, and digital standards are a few of these problems (Ciciora, 1995).

c. *Voice Dial Tone Gateway*

A device called a Voice Dial Tone (VDT) gateway connects the set-top unit to the video server. The VDT gateway serves several purposes, the most notable of which is connection of the user to the ITV system. The gateway also presents a menu of available information-provider services to the user and it links the subscriber terminal to information that he had requested. It disconnects the session when either the information provider or the user requests disconnection. Finally, the VDT can insert value-added features into the system, such as billing, security, and monitoring (Chang et al, 1995).

The protocol between the set-top and the VDT gateway is extremely important because it affects the identification of and connection to different applications. While this feature is often viewed as a directory service application, there are some unique aspects of the service. It governs the network channel that the set-top and VDT gateway use for service and remains active while other applications are running in order to maintain control of the network delivery. This would indicate that the interface must be well-enough defined to enable the set-top to select the correct downstream channel while retaining connectivity with the VDT gateway (Chang et al, 1995).

Differences in geographic location should cause no problems for the ITV user. The VDT gateway will govern the signaling and protocol aspects of the communications process. There is a problem, however, that is created with distance between server and set-top device. Greater distances cause a latency that affects the response time. The end result is a screen "jittering" that is easily detected by the

user. To correct this problem, the set-top box must respond to some user commands at the same time the box transmits them to the server. This immediate response requires the set-top to buffer incoming signals. (Chang et al, 1995)

d. Video Transport Technology

Improved video distribution systems are needed before ITV becomes a reality for the public at large. In order to accommodate the variety of networking technologies in common use, the video distribution systems must provide open-systems interfaces to the distribution networks. (Chang et al, 1994)

The broadband networks upon which ITV relies are asymmetrical. They have high bandwidth capacity from the video server to the set-top (the downstream channel) and lower bandwidth capacity from the set-top to the video server (the upstream channel). Typically bandwidth downstream is 3 Mbps, and upstream 1.5 kbps. The greater downstream bandwidth handles compressed video and audio, while the lower-capacity upstream connection carries the signals from user that control an interactive application on the video server. (Natarajan, 1995)

One of the greatest challenges to the ITV industry is the medium itself. Telephone companies and cable networks already have cabling running to most households in the country, but the capacities of coaxial give the cable networks a decided advantage. This is because of the greater bandwidth, or signal carrying capacity, over long distances that coaxial cable has in comparison with the telephone's twisted pair wiring. (Stallings, 1994)

The latest word in cabling is fiber optics. It has several advantages over the more traditional copper that is found in both coaxial and twisted pair wiring. These advantages include lower attenuation rates, negligible resistance, and the elimination of crosstalk on fiber optics systems. Loosely translated, the fiber optic system can transmit a purer signal over greater distances than can the copper wires. The big disadvantage is cost. Running fiber optics to most households is simply not financially feasible. (Stallings, 1994), (d'Angeac, 1994)

One way to reduce the cost of fiber systems is to develop hybrid systems that use fiber optic trunk lines while running copper to the houses. This provides the long-distance advantages of fiber but reduces the cost by relying on existing copper lines to the house.

Even with the appropriate cabling in place, bandwidth limitations are still major problems. Compression facilitates the transmission of bandwidth-intensive signals, like those that carry multimedia data. To illustrate, an uncompressed full screen (640-by-640 pixels), color video running at 30 frames per second (fps) requires approximately 208 Mbps of bandwidth. This is unacceptable. Compression reduces the requirements to feasible, if still high, limits. (Hurwicz, 1994)

Compression/decompression can be controlled by either hardware or software. Software decompression is usually done by the user at the workstation. While the normal limitation is 15 fps, speeds of up to 25 fps can be obtained by high-end systems. Hardware decompression supports rates of 30 fps, but requires relatively expensive compression/decompression (codex) cards. Broadcast band television, by comparison, normally runs at 25 fps. The motion picture industry uses the increased speed of 30 fps. (Hurwicz, 1994)

The Motion Picture Experts Group (MPEG) format is probably the most popular hardware compression format currently in use. It is used for distributing non-editable, full-motion video. The current version, MPEG-1, requires 1.2 Mbps of transmission capacity, which equates to 9 MB per minute of storage requirements. (Hurwicz, 1994)

The technological problem most often cited is the means by which signals are transmitted from the customer to the central switching office. AT&T has developed what it hopes will be the answer to this problem. The AT&T Video manager ties together set-top terminals, broadband transmission and switching systems, and video servers. It also manages the bandwidth required for the pathways between viewers and video servers. (*Edge*, 1994b)

Other problems abound. Determining the best modulation technique for user to video-server transmissions has not yet been conclusively answered. Other technological challenges include choosing a digital video modulation scheme that is capable of handling peak loading requirements, determining how services are routed and processed at the customer premises, and building the proper analog to digital bridges. (Ratcliffe and Dawson, 1994)

4. Developments

In the early part of 1994, many information systems experts thought that the introduction of mass digital communications was almost upon us. The competition between telephone companies and cable networks for market-share of this potential multi-billion dollar per year industry was thought to be sufficient to ignite a new era of communication. Due to the high investment needed to gain foothold in the industry, however, the competitors are taking a second look at ITV before jumping into the market. (Ratcliffe and Dawson, 1994)

Most experts now agree that interactive applications are at least a decade away from mass availability. The interconnection of systems needed for transport of video across regional boundaries is hampered by tremendous difficulties. The poor quality of existing coaxial in-home wiring is one of the greatest limiting factors. The cost of replacement is staggering. The potential benefits of interactive TV, however, are driving systems designers towards realization of a nation-wide interactive TV network. (De Groot, 1994b)

Another key point to remember is that new computers are needed at both ends of the ITV network. At the client end, digital set-top boxes are much more than simple tuners or descramblers. Hard decisions concerning the trade-off between functionality and cost must be made prior to their becoming available to the general public. Their cost must dip to the $300 before broadband ITV will become economical enough for general distribution. (Halfhill, 1994)

Video servers are at the other end of the ITV network. These tremendously powerful machines will require all of the expertise available today and then some if they are to become serviceable. (Halfhill, 1994)

Coping with network diversity is another hurdle that ITV must face. Elements from different sources have to work together without being specifically designed to do so. The server and set-top must tackle the equipment compatibility problem. The bandwidth and environmental characteristics of each technology must be taken into account. Transmission media, be it fiber, coaxial cable, twisted pair, or wireless media in various combinations is another problem that must be faced (Chang et al, 1994).

In the interim, analog television and video services are undergoing a revival. This revival may well be a final breath before being overwhelmed with the interactive digital programming of the future. (Ratcliffe and Dawson, 1994)

D. VIRTUAL REALITY

Virtual reality is a computer-mediated, multisensory experience. Von Schweber and Von Schweber (1995) go on to describe it as a means to "navigate and view" the three dimensional world with six degrees of freedom. Those degrees of freedom correspond to the six types of movement that the software is able to define and the hardware is able to recognize: forward/backward, up/down, left/right, pitch up/pitch down, angle left/angle right, and rotate left/rotate right.

Normally, a three-dimensional virtual "world" is a central part of virtual reality. This is a world that is created by deceiving the senses into hearing, seeing, and even feeling the presence of an artificially produced plane of existence. The goal of virtual reality is to fully immerse the user in his virtual world. This is best accomplished by providing output that can be received by as many of the user's senses as possible. (Cartwright, 1994)

1. User Interaction

Interaction brings the user into the virtual reality experience. It is the interface, however, that enhances it. There are three levels of immersion. In the first level, a regular PC monitor provides a window through which the user can interface with the virtual reality world. This window can be enhanced through the use of a stereo-ready monitor or projector, thus bringing the user to the second level of immersion. At this level, the user feels as if the image is reaching out through the monitor. The third, and highest, level fully immerses the user in the virtual world. He interfaces through the use of head-mounted display, the computer tracks the user's view and adjusts it accordingly. (Von Schweber and Von Schweber, 1995)

Virtual reality is not a form of passive entertainment. The user does not simply view the artificial world unfolding around him. Rather, the user drives the presentation, he becomes an active participant (Von Schweber and Von Schweber, 1995). This interaction is an integral part of the virtual reality experience (Hsu, 1993).

Many of today's virtual reality systems include capabilities to produce three-dimensional graphics, stereophonic sound, and tactile manipulation. This capacity to produce rich, multisensory worlds is critical to the quality of the virtual experience. The more senses that are involved, the more immersed one may become in virtual reality. (Cartwright, 1994)

A variety of input/output devices are used to create the virtual worlds. Helmets feed preprogrammed visual and audio information to the brain, overriding that which exists in the real world. Some systems are beginning to explore virtual tactile sensations. Data gloves and special joy sticks let the user interact more fully with his world, in some cases enabling him to actually feel the texture of virtual objects with his hands. Body suites are capable of carry the immersion factor to even greater heights. (Churbuck, 1992)

2. The Four Levels of Virtual Reality

Andrew and Ellis (1994) have devised a four-level scale that can be used to categorize virtual reality. The levels indicate different degrees of interaction between the user and his virtual environment.

a. Level One

In the first level there is no movement. The user can create a three-dimensional world and color, alter, and explore it as he sees fit. That world, however, is lifeless. The only movement is that of the user's viewpoint. For some purposes, such as architectural CAD programs, the first level is optimal.

The ability to build and experience a virtual product prior to investing time, money, and effort into building the real-world product is one of the benefits of the first level of virtual reality. For example, Superscape VRT3, which is software developed by Dimensions International, enables the user to "move, resize, rescale, and recolor objects." (Cheek, 1994)

Exploration of the real world is another benefit of Level One virtual reality. Opening-up locations that are either inaccessible or too distant for many people to visit is easily accomplished in virtual reality. Virtual wilderness trips (Mallory, 1994) and visits to many of the world's finest museums and art galleries are already becoming accessible to people from even the most isolated areas of the country (Rossello, 1994). The analysis of medical data collected by various medical procedures, such as PET and CAT tests, is yet another benefit of virtual reality (Delaney, 1994).

The storage and retrieval of data in today's information-intensive society is an ever-growing concern. The concept of Level One data virtualization, a "cyberspatial tool," shows much promise in this area. Virtualization, in an organizational sense, is the accessibility of every piece of information produced within the organization. This information is placed in "libraries" that are available at anytime, from any location. (Bauwens, 1994)

When accessing the libraries, there are three degrees of virtuality. The first degree provides the user with electronic access, but the real library is always in the background. The next degree provides electronic access to virtual collections, but with delivery of real documents. The third degree, which is currently in the development phase, provides electronic access to virtual collections of electronic documents. (Bauwens, 1994)

b. Level Two

The capability of bringing movement to virtual objects is the hallmark of the second level. This movement can range from simple dynamics, such as a rolling ball, to full simulation of physical properties. Molecular modeling, for instance, displays the laws of physics in its simulation of a world that is normally closed to people (Andrew and Ellis, 1994).

There are numerous possibilities for useful work in this second level of virtual reality. The transportation industry is investing in systems that enable it to train drivers, equipment operators, and pilots without danger to themselves and others. In the field of medicine, Dartmouth Medical School physicians are practicing surgery on virtual patients. In yet another application, NASA taught its astronauts the finer points of repairing the Hubble Space Telescope prior to the space venture. (Willmott, 1994) Even the arts are benefiting from Level Two virtual reality. Body surfacing, an art form that gives every movement the ability to produce fantastic colors and shadows, is an offshoot of Level Two virtual reality (Hsu, 1993).

Military training programs are also focusing in on Level Two virtual reality. One example of this is the Dynamic Combat Terrains, designed for infantry training, that is being developed by the Army Research Laboratory at Aberdeen Proving Ground, Maryland. (Morgan, 1994)

c. Level Three

Behavioral control characterizes the next level of Andrew and Ellis' (1994) virtual reality model. In these worlds, objects can be programmed to detect and respond to circumstances as they occur. The laws of physics need not be a

controlling force. There is much opportunity for useful work at this level. The movement of fluids, the interaction of mechanical parts, and even the modeling of human behavior are examples of work that can be accomplished in level three virtual worlds.

Perhaps one of the more interesting applications of Level Three virtual reality technology is demonstrated by the Virtual Egress Analysis System (VEGAS). This system is used to model the way in which very large numbers of people behave in emergency situations. Each member of a crowd of up to 200 people can be individually programmed to react in specified manners under emergency conditions. Firemen, policemen, National Guard personnel, forest rangers, and other people who may find themselves in crowd control situations have much to gain from VEGAS and similar systems.

d. Level Four

The fourth level of virtual reality has the ability to bestow artificial intelligence on the virtual objects that inhabit these worlds. Once created, a Level Four world can run on "automatic," objects require no further input from the user to interact with him and other objects. This level of virtual reality is currently beyond the abilities of current technology to achieve. (Andrew and Ellis, 1994)

3. Cyberspace

The ability to share one's virtual world with other people is having profound repercussions on the virtual reality industry. Multi-user access to a single experience has only recently become feasible. The ability to join forces with other people broadens perspectives tremendously. This is such a fundamental change from the past that a newly coined term, "cyberspace," is used to describe this sharing of virtual spaces. (Cartwright, 1994)

Cartwright (1994) contrasts the concepts of virtual reality and cyberspace by comparing the virtual reality/cyberspace experience to a virtual puppet show. When

one puppet is occupying the virtual stage, it represents an individual virtual reality. As soon as another player's puppet joins the first one and begins to interact, the virtual stage assumes the characteristics of cyberspace.

4. Technological Improvements

Improvements in technology are taking the user in two different directions. Hardware requirements are being reduced while the capabilities of desk top computers are improving. These two have met, resulting in virtual reality systems that can be run in the desk top environment at affordable prices. (Hsu, 1993)

Input/output devices are also making dramatic improvements. While system requirements are making virtual reality accessible to more people, input/output devices are undergoing a metamorphosis. Bulky helmets are being replaced by optical glasses. Tactile sensing gloves, while not yet common to all systems, are slowly filtering through the upper reaches of the market. As they become more readily available, they are also improving in quality. The higher grade models enable the user to "feel" the texture of virtual objects. (Rossello, 1994)

Like their virtual reality counterparts, cyberspace enthusiasts are finding technological improvements to their liking. Multiple-user experiences are more easily created in virtual-reality rooms (VROOMs) such as Electronic Visualization Laboratory's Cave Automatic Virtual Environment (CAVE) and the Virtual Reality Studio from Accolade. (Rossello, 1994)

5. Limitations of Virtual Reality

The major limitation in all of this is that of processing speeds. As these speeds increase, images become more clear and lifelike. Greater detail for all senses can be added, thereby improving the quality of the virtual experience. Realism can also be enhanced by using motion and complex behavior patterns along with the improved image quality. (Rossello, 1994)

Cost, always a limiting factor, is a hurdle that must be overcome prior to the dissolution of the processing speed problem. Costs are going down, however. With the price of electronics plummeting and the quality of electronic equipment rising, the

cost problem is rather quickly being reduced. Silicon Graphics is providing a basic, virtual reality system that can run in a desktop environment. Other manufacturers are following suite. This trend is likely to continue, bringing ever improving virtual reality capabilities to more and more desktop systems.

Other limitations fall on the human part of the system. Disorientation, vertigo, nausea, and inocular stress are all physical manifestations that can result from over-use of bulky virtual reality gear (Ellis, 1994). Mental stresses can also surface. Not only are more fragile individuals affected, but persons not normally considered to be at risk have been known to suffer problems as a result of over exposure to the unique conditions of virtual reality.

6. Augmentation of the Real World

When one speaks of virtual reality, the popular applications to the entertainment industry come readily to mind. Arcade games, motion rides that combine hydraulically controlled passenger seats and big-screen films, and three dimensional animation all create the illusion of alternate realities (Krum, 1995). One could argue that there is another side to the virtual reality coin, however. That is the augmentation of the real world (Wellner and Mackay, 1993).

Computer-augmented environments are focused on the merging of electronic systems into the real-world environment vice the creation of a virtual world. Absent is any attempt to create a separate and distinct "reality." In the augmented world the normal environment is an integral part of the system. Normal interaction among real-world elements still apply, but with an added integrated computer functionality. (Phillips Mahoney, 1994) In the augmented environment, most data visualizations take on familiar forms. The user is able to encounter real world experiences in ways that are not normally possible. For example, he may see air pressure and fluid flows that are not normally visible to the human eye. Infra-red optical sound is another example of augmented environment experiences. (Phillips Mahoney, 1994)

Another means of environment augmentation is that of remote control and manipulation. So far, the ultimate form of remote control is telepresence, the

bringing of users to remote sites. It has already proven its worth. Operators of highly specialized equipment require great amounts of training and experience. As a resource, these people are scarce and costly. Telepresence enables the parent organizations to place them into consolidated operator pools rather than sending them throughout the world to the physical sites. This gives the organization much greater flexibility in the allocation of the resource while eliminating lost resource-hours due to transportation requirements. It also places the operators in a safe environment and gives them the advantages of working in a fixed location, thus improving both morale and, ultimately, retention rates among the operators. (Churbuck, 1992) (Mitchell, 1993)

7. Developments

Virtual reality, as an emerging field, has much to offer in the way of real world applications. Santo (1994) tells us that, in the near-term future, virtual reality will be accepted for a variety of applications. Besides entertainment, virtual reality will impact such fields as telerobotics, scientific and advanced design modeling, medical imaging and rehabilitation, and education.

The potential for communication, remote control and manipulation, and for virtualization of data sources is tremendous. In an age when many educators and organizational development experts maintain that the human race has just about reached the limit of the amount of information it can assimilate, virtual reality offers a means of restructuring the manner in which people think. (Miller, 1992)

IV. THE USE OF MULTIMEDIA IN THE U.S. NAVY

The use of data services within government and industrial settings is growing at an unprecedented rate. Even as government and corporate users are beginning to recognize the value of multimedia, new technology is making its incorporation of organizational networks possible. This recognition will spur the use of voice, video, and imagery. Integrated workstations are among the latest manifestations of this new era of information management. The increasing capacity for digital connectivity provides an opportunity to transition from today's media-limited systems to the multimedia systems of the near-term future. (Vogelzang and Hodge, 1994)

A well-developed transition strategy is needed to support the assimilation of multimedia applications. An earnest effort in the development phases now will ensure a consistency of standards and technologies that will pay dividends in the future. The Navy is particularly concerned with teleconferencing, telemedicine, training, multimedia database management, industrial design and testing, and research and development. (Vogelzang and Hodge, 1994)

A. TELECOMMUNICATION INFRASTRUCTURE

Communication is the glue that holds otherwise unwieldy organizations together. Frequently the limiting factor to organizational success, it is not surprising that the effort to develop new and innovative methods of communication has been so strong, nor is it surprising that the excitement regarding achievement in the field of telecommunication has been so great. This section examines the U.S. Navy's telecommunication infrastructure to the extent that is relevant to the Navy's multimedia efforts.

Continuous, real-time communication between commanders ashore and their afloat counterparts will signal nothing less than the end of the isolated fleet unit. The U.S. Navy's objectives for telecommunications systems and services take into account

the impact of today's changing environment on telecommunications facilities. The objectives, which relate to specific requirements in the areas of traffic capacity, survivability, and security, include:

- The ability to grow with changing user requirements
- Increased interoperability
- Improved reliability and maintainability
- Reduction of the number of support personnel
- Increased use of commercial products (Vogelzang and Hodge, 1994)

There is a need for standard telecommunications interfaces that are capable of linking private industry and DoD. A GAO report of December 1993 recognizes the relationship between standard interfaces and the capability of civilian organizations to conduct business with the military establishment. The report cites the impact of interoperable telecommunications networks on procurement practices. According to that report, a common means of electronic data exchange between government and contractors will improve the overall procurement process by expanding the competitive base, thereby providing an opportunity to lower item prices. (Meadows, 1994)

Telecommunication also plays a role in maintaining acceptably high levels of morale during extended deployment. News programs keep crews informed about current events while satellite brings television from land to the vessels at sea. Now deployed ships can receive transmissions of major sporting events, such as the Super Bowl and the World Series, at the same time that they are broadcast to the rest of the world. (*Communication News*, 1994)

1. Global Environmental Grid Demonstration

One of the newest breakthroughs in data transmission technology is asynchronous Transfer Mode (ATM). ATM uses virtual data cell switching technology to provide high-speed data switching and the capacity to simultaneously transmit voice, video, and data over the same circuit. This makes it the ideal method

of multimedia transmission. The Global Environmental Grid Demonstration (GEGD) was the first federal government system to take advantage of ATM. It uses the technology to connect three remote Naval Research Laboratory's (NRL) activities. (Bass, 1994) (*Edge*, 1994a) (Masud et al, 1994)

The Washington, D.C.-based NRL is the Navy's corporate research laboratory. It conducts a broad-based, multi-disciplinary program of scientific research and advanced technology development for the U.S. Navy. To do so, its Remote Sensing Division (NRL/RSD) has workstations in Washington, D.C.; in the University of Miami's Rosenstiel School of Marine and Atmospheric Science in Miami, Florida; and in Oregon State University's College of Oceanography in Corvallis, Oregon. These three stations are connected by GEGD. (*Edge*, 1994a) (Masud et al, 1994)

GEGD's mission is geared toward maritime applications as well as ocean, atmospheric, and space sciences. Many of its applications require the transfer of large amounts of time-critical datasets. The imagery datasets, which can be 20 gigabytes or greater, are too large to store at each site and require too much time to transmit over present wide-area networks. A high-speed, ATM network connecting the three research centers circumvents these problems and allows researchers to share data, models, high-speed computing, and high-end visualization facilities. GEGD enables the Navy to test environmental applications with near- and real-time remotely-sensed data. (*Edge*, 1994a) (Masud et al, 1994)

2. GTE Government System's Proposal

Traditional methods of communication between submarines and shore-based command centers include militarized high frequency (HF), very high frequency (VHF), and ultra high frequency (UHF) line-of-sight and satellite communications systems. The transmission of electronic video communications with these traditional systems is not feasible. The GTE proposal demonstrated that the achievement of high data transfer rates on a deployed submarine was possible. (Endoso, 1994)

The demonstration took place on USS Albany, a 688-class attack submarine. GTE's Ku-band Portable Satellite Terminal was used in the experiment. An antenna, which served as the satellite link, was mounted on top of an existing mast. (Endoso, 1994)

Although it was necessary for USS Albany to expose the antenna by rising to periscope depth, the capability to send and receive data at transfer rates in excess of 64 Kbps made the risks of detection worthwhile. The submarine was able to exchange data and live video images, as well as to participate in teleconferencing sessions with officials ashore during the experiment. Furthermore, it was able to exchange encrypted data, video, images, and voice at a rates well above the 2.4 Kbps capacity of most modern submarines. (Endoso, 1994)

During the course of the demonstration, USS Albany captured video images of a nearby ship, processed and annotated the images in the submarine's Digital Equipment Corporation's Alpha 300 workstation, and transmitted the pictures to the shore establishment in Norfolk, Virginia. This, and other achievements, indicate that GTE's proposal will support tactical missions. Perhaps more importantly, the increased data transfer rates will make submarines more compatible with surface ships. (Endoso, 1994)

3. Project Challenge Athena II

Project Challenge Athena II was another successful experiment in telecommunication. It demonstrated image delivery capabilities, the use of commercial two-way satellite communications over an extended period of time, and the successful employment of multiplexer technology on a surface vessel. (Masud, 1994)

Athena II appears to have provided an answer for the Navy's need for high volume, high data-rate communications. Maritime Telecommunications Network (MTN), the communication services provider, tested its specialized common carrier service on USS George Washington while the aircraft carrier was stationed off the French coast. Full-time satellite communication channels were maintained for the

entire six-month experimental period. Transmission rates from 64 Kbps to 1.544 Mbps supported voice, facsimile, data, imagery, and video applications. (Masud, 1994)

The project demonstrated that direct delivery of multiple types of data between forces afloat and shore-based support activities, over extended time periods, was possible. The use of commercial two-way satellite communications and multiplexer technology were key ingredients in the experiment. MTN's digital network connects its wireless services through satellite to a digital fiber network. In addition to videoconferencing capability and access to remote databases, approximately 30 phone lines were available for the crew's use. These lines not only provided facsimile machine and e-mail accessibility, but they also gave the crew an opportunity to enjoy such shoreside privileges as in-bound dialing and access to automatic bank telling machines. (Masud, 1994)

The use of C-Band satellite service for wideband communications in this experiment represents a tremendous advance over earlier Ku-band experiments. The advantage of C-Band is the breadth of its coverage. When compared with Ku-band coverage, C-band spans a relatively large portion of the earth, thus making a truly global communications system a near-possibility (Masud, 1994).

The success Project Athena II has paved the way for a new era in naval operations. According to Captain E.R. Enterline, director of the Navy Space Systems Division, this demonstration moved afloat Command, Control, Communication, and Intelligence (C3I) technology forward by unprecedented degrees. The merging of user-controlled multiplexing technology with national imagery capabilities shows much promise in future communication systems. (Masud, 1994)

B. TELECONFERENCING

The use of teleconferencing technology within the U.S. Navy is currently receiving a lot of attention. Teleconferencing has been embraced as a means of sharing and disseminating information. New advances in data transmission

technology and DoD's recognition of civilian transmission services as a viable alternative to military services are opening possibilities that have previously been overlooked.

The Navy's Patuxent facility is an example of the service's investment in this technology. Patuxent Naval Air Station has recently awarded a $21.9 million contract for telecommunications services. Working with Maryland Bell Atlantic Federal Systems of Silver Springs, a base telecommunications system will be built and supported under a seven-year contract. (Endoso, 1995)

While telecommunication between naval ashore facilities is able to use much of the same technology that private businesses and other government agencies employ, afloat units offer unique challenges to the telecommunication field. Magnavox Electronics Systems has focused its efforts on this area. Their marine and transportable satellite communications terminals were used in a recent study on videoconferencing with deployed naval units. The Inmarsat Satellite Earth Station (SES) equipment was used for data transmission and reception. The communications facility was used to provide a link between on-shore officers and their shipboard colleagues, for remote education and training of shipboard personnel, and for entertainment. (*Communications News*, 1994)

The naval units quickly found uses for the videoconferencing capabilities other than the command and control operations. The new communications technology opened training and educational opportunities for the sea-going sailors that were previously unheard of. During this study the crews were able to interact with, and benefit from, instructors that were thousands of miles from the ship. (*Communications News*, 1994)

C. TELEMEDICINE

Telemedicine is a specialized subset of teleconferencing. It requires real-time communication and high resolution imagery to be effective. Video and advanced graphic capabilities are also necessary for a successful telemedicine service.

1. Maritime Health Services' Medical Consultation Network

The Maritime Health Services' Medical Consultation Network (MedNet) is an occupational health service that enables on-board medical officers to communicate directly with physicians. Work within this program has, to date, been limited to the commercial fishing industry. The technology, however, can be readily applied to U.S. Navy and Coast Guard uses. (Jarris, 1994)

The advent of powerful new desktop microcomputers with high resolution monitors have, in conjunction with the advances in the data transmission system and the adoption of the Inmarsat satellite communications system, ushered in a new era of telemedicine. Distance medical service has gone beyond the electronic equivalent of the 911 emergency call of the last decade to a fully integrated system that enables the remotely located physician to examine his patient, view X-rays and CT scans, and guide onboard medical assistants through fairly intricate procedures. With more than 2000 consultations over a three-year period, MedNet has already proven its worth. (Jarris, 1994)

The concept of remote medical consultation has been around for a long time. The arrival of personal computers equipped with digitizing boards, high resolution monitors, and data links over standard telephone lines brought true telemedicine status to the system. The videoconferencing-based telemedicine service provides a live audio-video link between ocean-going vessels and emergency physicians. It enables the remote physician to examine, diagnose, and treat his patients. (Jarris, 1994)

2. Project Challenge Athena II

While not intended solely as a telemedicine demonstration, the telecommunications experiment that was held aboard USS George Washington did prove the worth of telemedicine services. During the course of the demonstration there was a medical emergency onboard the ship. The ship's doctors were able to transmit X-rays to a specialist ashore who added his expertise to patient's diagnosis. (Masud, 1994)

In this case, the ability to share multimedia data with the specialist saved the government the expense of an emergency personnel transfer and spared the injured sailor from additional pain and, perhaps, permanent injury. More importantly, the potential for saving lives dramatically emphasizes the value of the capacity to share multimedia data between ship and shore stations. (Masud, 1994)

D. TRAINING

Training has long been recognized as an area of prime importance within the Navy. Approximately 7,800 courses are delivered to 73,000 naval enlisted and officer students each year (CEP, 1988). There is no easy solution to the problem of delivering those courses to globally dispersed naval personnel. A number of different strategies have been implemented. Two of these strategies, both of which rely on ongoing advances in the fields of telecommunication and information technology, encompass distance learning and simulation.

1. Distance Learning

Like traditional users of distance education technology, the U.S. Navy faces training requirements for students that are distributed over a broad geographical area. Its training centers, on the other hand, are concentrated in only a few sites. Distance education technologies offer a solution to this problem by enabling the instructor to remain in one location while his students occupy one or more remote sites. (Simpson et al, 1991b)

Those distance learning technologies that are most suitable for Navy training enable groups of students to be trained simultaneously classroom situation that mimics the traditional live classroom setting. Ideally, there is a substantial amount of interaction between the instructor and students. (Simpson et al, 1991a) (Simpson et al, 1991b) Various forms of videoteletraining (VTT), audiographics, and videotape fall into this category. While all of these technologies have been used effectively in public education, Navy use has been limited. (Simpson et al, 1991a)

Educational, industrial, and military organizations are now beginning to take advantage of recent advances in electronic communications systems to provide education and training to students at remote sites (Pugh et al, 1992). Compressed-bandwidth TV, videotape, audiographics systems, electronic mail, audio conferencing, and computer-aided instruction are examples of electronic technologies that lend themselves well to distance learning situations (Simpson et al, 1991a).

a. Defense Commercial Telecommunications Network

The Air Force Institute of Technology's (AFIT) graduate school was one of the first educational institutions to implement distance learning as a regular part of its curriculum. AFIT uses a one-way video, two-way audio system. With this system, the students are able to see the teacher and any illustrative material that he cares to present. The teacher, in turn, can listen to and discuss class lessons with his students. (Westfall, 1994)

In conjunction with AT&T, AFIT developed and implemented a satellite-based inter-operable system that enables all DoD departments and agencies to take advantage of the educational opportunities offered by the academy. This system, the Defense Commercial Telecommunications Network (DCTN), supports multimedia educational programs. (Westfall, 1994)

DCTN takes advantage of such communications technology as HF radio, terrestrial line-of-sight microwave, and both terrestrial and undersea cable to open lines of communication throughout the world. Fiber optic technologies, whose performance already exceeds that of any other media, are playing roles of ever-increasing importance. (Westerman and Bodson, 1992)

The advantages of DCTN has caused it to expand beyond the realm of training and education. It was combined with the AUTOVON network to form the Defense Switched Network (DSN), a system that provides communication capabilities to defense branches and agencies throughout the world (Westerman and Bodson, 1992).

b. Electronic Schoolhouse Network

The Chief of Naval Education and Training's Electronic Schoolhouse Network (CESN) project is based at Fleet Combat Training Center, Atlantic. Operational since early 1989, the network consists of five satellite-linked sites. Two-way video and two-way audio are available at each site; thus, both video and audio can be originated and received at any point within the system. (Simpson et al, 1991a) (Simpson et al, 1991b) (Pugh et al, 1992)

Although still regarded as experimental, CESN has delivered about two dozen different courses to several hundred students. Most of the instruction has been lecture-based and lasted for durations of less than a week. CESN is the prototype of a much larger, multipoint satellite-based VTT network. An implementation plan calls for expansion of the network, with nation-wide coverage as the desired outcome. When completed, this network will be the largest and most complex VTT system yet created (CNET, 1990) (Simpson et al, 1991a) (Simpson et al, 1991b) (Pugh et al, 1992).

(1) Videoteletraining. Videoteletraining (VTT) is an adaptation of distance learning. Its value as a training tool was foreshadowed by Instructional Television (Instructional TV), a popular and more traditional training tool. VTT's origins, however, are actually more closely aligned with Videoteleconferencing (VTC) methods than with those of Instructional TV. (Pugh et al, 1992)

Instructional TV systems range in size and complexity from single-campus closed-circuit TV systems to nationwide networks linking dozens of campuses. Normally, Instructional TV systems consist of one-way video and two-way audio, with the return audio link from remote to originating site often being provided by the telephone. (Simpson et al, 1991a) Instructional TV is widely used in public education, but its use by the military is limited (Simpson et al, 1991b).

VTC systems, with their strong emphasis on interactivity among small groups of conferees, have been used to develop models of VTT systems. It is the interactive aspect of VTC that differentiates it from the more standard

Instructional TV. Like VTT, VTC relies on digital compression techniques for two-way video communication on bandwidths that are somewhat smaller than those that are used in Instructional TV. (Pugh et al, 1992)

Studies indicate that VTT is an effective method of delivering training to naval personnel who are stationed at sites that lack training facilities (Rupinski and Stoloff, 1990) (Simpson et al, 1990) (Simpson et al, 1991a) (Simpson, 1993). The VTT training design philosophy is to make training as similar to live instruction as possible. This simplifies adaptation by instructors and students, minimizes costs, and addresses the minimal cost VTT system concept. (Simpson et al, 1991b)

One aspect in which VTT differs from Instructional TV is the presence of students at the originating site (local classroom) as well as at the receiving site (remote classroom). This presence fosters a feeling that the VTT site is, indeed, a classroom. The result of this resemblance is enhancement of the VTT learning experience. (Simpson, 1993)

Mimicry of the traditional classroom helps not only the students, but also the instructor by simplifying adaption to the new medium. Students, whether in the local classroom or one that is remote, are encouraged to ask questions, make comments, and engage in discussion. Mimicking the live classroom setting also minimizes instructor training requirements and reduces the number of changes to training materials and aids. Most importantly, it encourages the same instructor-student and student-student interaction that is so familiar in more traditional settings. (Simpson et al, 1991b) (Simpson, 1993)

Unfortunately, the mimicking of the live classroom can at best be approximated. Traditional interaction conventions must be modified somewhat for VTT. For instance, the VTT instructor controls activities at more than one learning site. He must keep students in all sites actively engaged in the pursuit of skills and knowledge. (Simpson, 1993)

The classroom itself must be adapted for VTT (see Figure 5). Care must be taken so that the cameras, monitors, facsimile machines, and so forth do not make it look more like an electronics equipment sales floor than a place to learn. Placement of equipment in out-of-the-way positions, such as hanging from ceilings and in corners of the room, helps to alleviate the problem. (Simpson et al, 1991b) (Simpson et al, 1992)

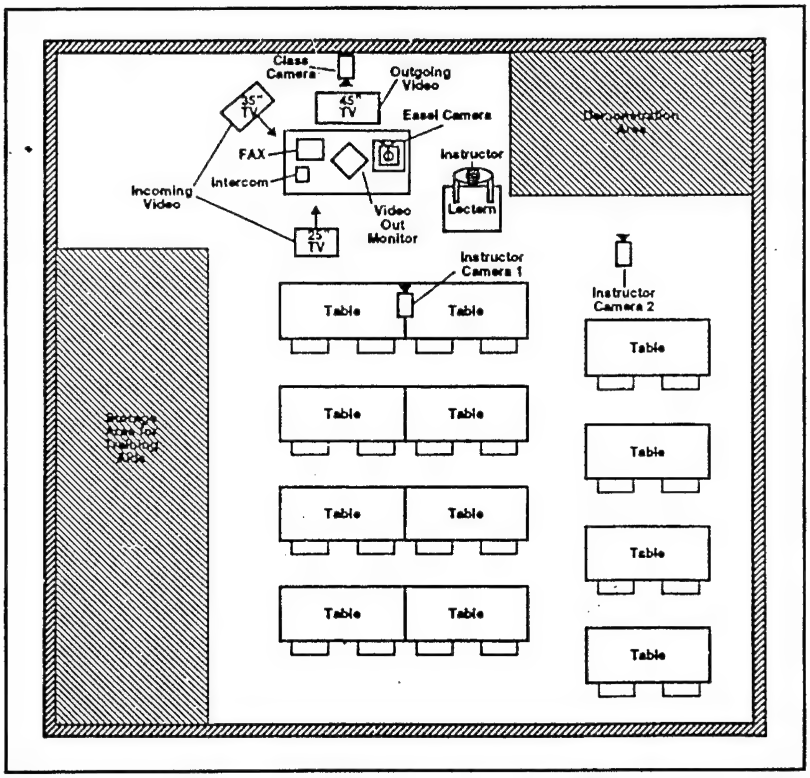

Figure 5. Videoteletraining classroom configuration. From Simpson et al (1992)

The differences between Instructional TV systems and VTT systems can best be illustrated by comparing two military systems. The US Army Satellite Education Network, originating from Fort Lee, VA, is an example of a military Instructional TV system. It has been in operation since 1985 and connects Fort Lee to 58 receiving classrooms throughout the continental US. The Navy's Electronic Schoolhouse Network is a VTT system. (Simpson et al, 1991b)

The Army network uses one-way video, serves many sites, and requires well-equipped studios with large support staffs. Production values are given high importance. The smaller Navy network uses two-way video, has minimal support staff, and requires only minimal instructor training. Production values and instructor performance are generally secondary to the emphasis on a more traditional classroom look. The interaction that is made possible by the use of two-way video and audio tend to compensate for lack of refinement in lighting, sound, timing, and other elements of professional-quality broadcasting. (Simpson et al, 1991b)

(2) Videoteletraining Issues. The primary benefit of VTT is its cost-effectiveness in the training of remotely located personnel. Much effort is placed on providing the same quality-level of training for remote students as that received by traditional students. There is, however, a trade-off between the quality of the training and the cost of the training. Studies indicate that live training, due to familiarity of the traditional classroom, access to the instructor, and the proximity of training aids, cannot be replaced by even the most advanced distance-training techniques. (Rupinski and Stoloff, 1990) (Simpson et al, 1990) (Simpson et al, 1991b) (Pugh et al, 1992)

The primary reason for using alternatives to the traditional classroom training setting is the potential for cost savings that are inherent in these systems. VTT reduces training delivery costs (Simpson, 1993). While training is inherently an expensive operation, distance learning systems, such as VTT, have the potential to reduce this expense. Travel, per diem, and travel time lost to the student's command can all be saved if the command can avoid sending the student to remote sites for training. The use of such technology also increases training opportunities by making the training available to a wider spectrum of personnel, thus improving the efficiency of training programs. (Simpson et al, 1991b)

There are offsetting costs that creep into savings gained by local training. Instructor training is one such cost. VTT principles counter this problem by making VTT as similar to live training as possible. It has been demonstrated that qualified Navy instructors can become competent VTT instructors with little training

(Simpson, 1993). Instructors usually gain skill and confidence in the VTT classroom at a rapid pace. A few hours is normally all that is needed for effective functioning of instructors on their first VTT assignment (Simpson et al, 1992).

The minimization of training personnel and support requirements also helps to keep distance learning costs low. Removing the requirement to place students and instructors at the same location will reduce travel and per diem costs of instructors and students. An additional benefit is that the number of training personnel will be reduced because a single instructor is no longer limited to the number of students who can comfortably work in a single classroom. (Simpson, 1993)

One problem with VTT that is not present in live classroom instruction is system reliability. Weather conditions and microwave signals can interfere with satellite transmission. The size of the geographic areas over which VTT systems work also may cause problems. Further difficulties may arise when transmissions cross governmental and legal jurisdictions. Teacher accreditation requirements, for example, may differ between the point at which a video course originates from that where it is received. (Pugh et al, 1992)

In the end, it is the effectiveness of the training program that is the true measure of success. The Center for Naval Analyses determined that the difference between final grades of students at remote and originating sites are not practically significant (Pugh et al, 1992).

c. *Communication Networks In Training*

Communication Networks in Training (CNIT) is a project that is being conducted by the Navy Personnel Research and Development Center of San Diego, California. The CNIT project is a part of the Schoolhouse Training product line, a major research effort that falls under the auspices of the Chief of Naval Education and Training. (Simpson et al, 1991a) (Simpson et al, 1992) (Simpson, 1993)

CNIT's objective is to find a more cost-effective means to train geographically dispersed personnel with relatively limited training resources (Simpson et al, 1991a) (Simpson et al, 1992) (Simpson, 1993). Different technologies, research

and development projects, and the Navy's training problems have been studied in an effort to gain a better understanding of which technologies hold the greatest potential for future use in the Navy (Simpson et al, 1991a).

Much of the work has been involved with the exploration of the use of new communication technologies to export training to geographically-remote students. Among these technologies are computer networking, instructional TV, videotape, audiographics, videographics, and other media. As in the CESN project, VTT is the focus of the CNIT project. (Simpson et al, 1991a) (Simpson et al, 1992)

One way to categorize available VTT technologies is by degree of interactivity between local and remote sites (Simpson et al, 1991a). That categorization is listed below:

- Two-way Video with Continuous Two-way Audio
- Multi-channel Two-way Video with Two-way Audio
- One-way Video with Two-way Audio
- One-way Video with One-way Audio
- Videotape
- Audiographics

A comparison of the various technologies indicates that the most successful VTT technologies are those with two-way audio. This audio configuration enables students to interact with the instructor, resulting in performance scores that are comparable with those students in live classroom settings. Two-way video, on the other hand, does not appear to have as large an impact on student performance as does two-way audio. However, instructors and students alike indicated a preference for two-way video over one-way-video. (Simpson et al, 1991a)

While those technologies with one-way audio and audiographics do not work as well as fully-interactive technologies, they have at least a limited effectiveness. There is a significant cost difference among the various technologies that should always be appraised. (Simpson et al, 1991a)

(1) Course Types. One of CNIT's findings is that VTT technology must be flexible enough to adapt to a variety of course types (Simpson, 1993). The course's subject matter places differing requirements on VTT technology. While recognizing that there are numerous possibilities, CNIT studies limited their focus to only three distinct VTT course types. These are lecture-based courses - courses that combined lectures, demonstrations, and hands-on laboratories - and small-group courses. (Simpson et al, 1991b) (Simpson et al, 1992) (Simpson, 1993)

CNIT conducted a laboratory study to determine the effectiveness of VTT methods on three different types of classes. This study, which involved 215 Navy students, indicated that VTT was effective for lecture, discussion, and hands-on demonstration portions of training. (Simpson et al, 1992)

The primary emphasis on a lecture-based course is a flow of information from the relatively stationary instructor to students. During most of the course, the instructor lectures from a stationary lectern at the front of the classroom. An instructor camera and microphone are needed to transmit the lecture to remote sites. (Simpson, 1993)

Instructor-student interaction is an important element of lecture-based courses. The interaction consists of questions, comments, discussion, and other verbal discourse between students and instructor. Student voices must be picked up with microphones and projected with public address systems. In two-way video systems, the instructor sees students with the aid of a camera that is located in the remote class. (Simpson et al, 1992) (Simpson, 1993)

Lectures are often accented with charts, graphs, and other written material. It is more effective for the VTT class to substitute hard copy for the transparencies and writing boards that are usually used in live class settings. The hard copy can then be viewed with the aid of an easel camera. (Simpson, 1993)

The lecture/demonstration class, with its accompanying hands-on laboratory, proved to be a more difficult class type to convert from live to VTT classroom settings (Simpson, 1993). In addition to lectures, hands-on courses usually

include demonstrations with training aids and hands-on laboratory sessions. This means that, besides the equipment that is required for a lecture-based class, additional equipment is needed for the demonstration and laboratory portions of the course. Designing a VTT classroom that is capable of converting the demonstration and laboratory portions of the class from live to VTT can be most challenging (see Figure 5). (Simpson et al, 1992)

The demonstrations can either be videotaped ahead of time of done live in the classroom. While videotape frees the course from the restrictions of limited classroom demonstration and training aids, it does so at the expense of loosing the interactive element that is inherent in a live demonstration. (Simpson, 1993)

Adapting the laboratories for remote-site delivery is another difficulty found in hands-on VTT courses. Duplicate laboratory equipment and videotaped laboratory demonstrations can be helpful for this type of training. Also helpful is a facilitator. He supervises the laboratory, provides safety assurance, and certifies performance (Simpson et al, 1992). Students can present their work by using the easel camera. Individual help is provided to the remote students either by the facilitator or by the instructor via intercom. (Simpson et al, 1991b)

Small-group VTT classes rely on lectures with accompanying visual aids, but the emphasis is on discussion and small-group activities (Simpson, 1993). Much of the same equipment required for the lecture-based course can be used for this type of class. The biggest difference is that the student body is divided into small groups. Continuous audio is neither required nor, in most cases, desirable. Each group of approximately six students works as a team with one of their number serving as the group's spokesman. He comes before the entire class to make presentations from the instructor's position. (Simpson, 1993)

(2) Communication Networks in Training Issues. The most consistently reported problem is audio. Complaints range from static on telephones, audio feedback, fluctuations in volume, insufficient numbers of microphones, poor placement of audio equipment, and echo. There is a trade-off between the number of

live microphones on the system and the likelihood that severe audio problems will occur. Too few microphones inhibit interactivity while increased numbers makes it more difficult to keep audio problems in check. Another problem is extraneous noise in the classroom. At one site, for instance, a wall air conditioner had to be turned off in order to allow the audio system to function. (Pugh et al, 1992)

Shortcomings in the audio systems have a most negative affect on the quality of VTT learning experience (Simpson et al, 1991a). This is because the audio signal carries much of the information that is critical to the successful flow of information between instructor and student. A poor video signal, by comparison, will not prevent the student from following the lecture. Loss of a clear audio signal, though, will prevent the student from understanding the lecture regardless of the quality of the video transmission. (Simpson et al, 1991b) (Pugh et al, 1992)

Another problem, this one brought on by the use of audio/video equipment, is constraint. The fixed cameras force instructors to restrict their movement, both left and right to remain in the picture frame and forward and backward to remain in focus. Classroom procedures are also constrained. The audio/video equipment used, classroom design, and the requirement to conduct training and manage multiple classes simultaneously all have an impact on the quality of instruction given in a VTT environment. (Simpson et al, 1992)

There is much concern about the quality of training the remotely located students receive. Evaluations of interactive VTT systems indicate that the performance of students in originating classrooms is comparable to those in receiving classrooms. Other measures, such as student attitudes, also indicated that there was no significant degradation of the learning experience in remote classrooms. One exception to the similarities is that remote students tend to feel a lack of access to the instructor. (Simpson et al, 1991b)

CNIT studies indicate that VTT is effective both in terms of student performance and student and instructor acceptance (Simpson et al, 1990) (Simpson et al, 1991a) (Simpson et al, 1991b) (Simpson et al, 1992). Student

performance and attitude are affected by the type of VTT technology used, but student experience tends to overshadow the effect (Simpson et al, 1991a) (Simpson et al, 1992).

2. Simulation Training

DoD has long been the standard bearer in simulation training. Overall decreases in military spending, from a 1993 high of $1.035 billion to an anticipated $794 million in 1997, are making the conservation of financial assets a top priority. This tightening of the budget makes the use of simulated training, which is generally less expensive than real-world training, more important than ever. (Grimes, 1993)

The use of simulated training environments is expected to continue increasing over the near-term future. The Navy's accelerated use of simulators is being driven not only by reductions in training budgets, but also by base closings and by a need to more closely replicate combat conditions (Banwell, 1994). All of these factors combine to place demands on increasingly scarce resources that require maximum utilization of assets (Grimes, 1993).

DoD has grasped the value of standard-based solutions and open products. Standardization makes the simulation development process quicker and easier to accomplish. The reduction of training and maintenance costs over the service life of the systems is another byproduct of standardization. The use of open products compliments standard-based solutions. These products make it possible to use less complex simulators on standard platforms without significant reduction in capability of the overall simulation system. (Stihl, 1994)

With a shifting emphasis from open-ocean warfare and antisubmarine warfare to amphibious operations and littoral-water missions, Navy training needs are changing. The new missions place an emphasis on joint training exercises. To keep pace with the dynamic demands of today's military environment, the new simulators

must be reconfigurable. Another change is a shift toward deployable simulators. The elimination of shore billets is driving this trend in both the Navy and the Marine Corps. (Grimes, 1994)

Thus the new simulators are portable and deployable. They are designed to support refresher training and mission rehearsal on aircraft carriers and amphibious ships as they deploy on extended power projection missions. Computer-based training and interactive courseware, video teletraining, and integrated team training systems are needed to support these units. Also needed are increased simulator fidelity and more advanced instructors stations if the increasing demand of simulator use is to be properly met. (Grimes, 1994)

a. East Coast Littoral Warfare Training Complex Initiative

DoD's emphasis on joint training has resulted in the East Coast Littoral Warfare Training Complex Initiative. This complex will provide training for Navy, Coast Guard, Marine Corps, Army, and Air Force personnel. Located on the East Coast between Norfolk, Virginia and Camp LeJeune, North Carolina, it will provide an unprecedented opportunity for the services to conduct C^3I training. The services will also be able to perform air, land, and sea force-on-force threat environment exercises at the training complex. Both real and simulated weapons systems will be connected into a virtual combat environment. (Grimes, 1994)

Increased satellite transmission rates and communications bandwidths must be capable of supporting the multimedia applications needed for the simulated portions of the East Coast Littoral Warfare Training Complex. Secure data links and encryption devices, non-intrusive data collection systems, and improving semi-automated force-tactical environmental simulation are all used in littoral warfare training. (Grimes, 1994)

b. Distributed Interactive Simulation

Although the military community has placed much value on simulated training, there has been a decided lack of coordination among the various training communities. Much of the work in the field has been done independently, with few

links among related programs, thus disallowing the greater efficiency that could be obtained in an integrated simulated training system. A final obstacle to the development of a truly effective simulation system has been the absence of a forum for professional review and critique within the military establishment. The Distributed Interactive Simulation (DIS) system is an attempt to circumvent these shortcomings. (Bettencourt and Lactera, 1992)

DIS takes advantage of the advancements in simulation, telecommunications, and information systems that make the development of a fully integrated mission rehearsal system feasible. It combines the training opportunities of a synthetic environment with the distributive advantages of a global communications network to form a simulated training network that is unencumbered by the widely dispersed nature of the U.S. military community. DIS has the capacity to link both individuals and teams over widely distributed multiple sites. The participants are given the opportunity to interact with the system and with each other in a shared environment. (Tarr, 1993)

Originally spearheaded by the U.S. Army, DIS was developed in response to the need for an "accredited, real-time, warfighter-in-the-loop simulation" of the joint and combined battlefield. In an effort to fulfill its requirement to conduct tests and analyses in support of decision making for such broad areas as force modernization, DoD has adopted DIS as a viable tool. (Bettencourt and Lactera, 1992) A Defense Department Information and Analysis Center has been created to pursue and disseminate relevant data and information to other government customers. New emphasis on jointness and the Navy's "From The Sea" policy make naval participation in the program crucial to the country's defensive posture. (Tarr, 1993)

Realism is essential in interactive simulation training. Great care is given to provide basic data on physical phenomena related to the battlefield environment. This data, which is infused directly into the virtual world, includes atmospheric data, weapons effects, and electromagnetic effects. DIS provides some

of its data for feedback to closed form analysis models. Ultimately, warfighting capability will be enhanced as superior weapon systems are fielded. (Bettencourt and Lactera, 1992)

DIS is advantageous to the services for a number of reasons. It surmounts the limitations, expense, and many of the difficulties encountered in traditional methods of material development, combat development, and operational testing. Troop availability, environmental impact, safety concerns, time factors, increasing costs, and the need for warfighter-in-the-loop can all be more easily addressed with the help of DIS. One of the more publicly acknowledged uses of this type of technology is the Army's use of DIS through representations of combat conducted in an electronic battlefield. High-tech computer systems, interactive combat models, and real manned and unmanned equipment are all parts of the electronic battlefield. (Bettencourt and Lactera, 1992)

(1) Simulation Types. DIS interacts with military personnel in three different ways: through virtual, constructive, and live simulation environments. In virtual simulation, military personnel actively man simulators that, with the aid of the simulation network and the Close Combat Tactical Trainer (CCTT), place the personnel in the virtual battle. (Tarr, 1993) The key to this level of interaction is the fully representative battlefield environment. It offers both full human interaction and any number of required iterations. (Bettencourt and Lactera, 1992)

The second type of simulation is constructive simulation. It is the base upon which Command, Control, Communications and Intelligence Electronic Warfare (C^3IEW) is built. This type of command and control training, often referred to as war games, tends to involve large unit operations and is played on an electronic battlefield in a near real-world timing scale. It is at this level of interaction that DIS will make the best use of links with to other services. Insights in the joint arenas at the tactical, operational, and strategic levels is a primary benefit of constructive

simulation. Successfully implemented constructive simulation will enable a new level of universality in simulation training systems to be achieved. (Bettencourt and Lactera, 1992) (Tarr, 1993)

Finally, live simulation training is based on the premiss that everything but combat is simulation. Major field exercises, such as the National Training Center (NTC), use live fire ranges with instrumentation, and Multi-Integrated Laser Engagement System (MILES) equipped soldiers and equipment. (Tarr, 1993)

(2) Simulation Network. One of the more widely accepted adaptations of DIS has been through the Simulation Network (SIMNET) program. The Army's training community has been a strong proponent of this environment. They have long since recognized the need for a realistic environment in which to develop training concepts and techniques. Traditional field exercises conducted to satisfy this need are increasingly expensive and often do not sufficiently stress the man or his equipment to adequately evaluate training strategies. DIS, through the agencies of the SIMNET program, has provided the realistic training environment without the disadvantages of the traditional field exercise. (Bettencourt and Lactera, 1992)

(3) Objectives. One of DIS' goals is to integrate the three types of simulations systems. There has been much progress in attaining this goal. The training exercise Reforger 1992, for example, combined US troops that were based in Germany and in the United States. In spite of the use of heterogeneous simulation systems, the exercise enjoyed a high degree of success. (Tarr, 1993)

Another goal is the development of a seamless interface between real world Command, Control, Communication, Computer, Intelligence (C^4I) and Model and Simulation (M&S) systems. This seamless interface would enable the military establishment to train with the same systems that would be used in actual combat. (Bettencourt and Lactera, 1992)

(4) Distributed Interactive Simulation Issues. Restrained budgets and changing military commitments demand a continuing need to conduct analyses in support of material development and acquisition. The ability to rapidly prototype new systems has never been more valued than it is today. Early recognition of form, fit, and function of proposed systems is possible in a simulated environment. Not only is it important to evaluate individual system capabilities in the earliest design stages of development, but also the combined effects of multiple systems need to be accurately estimated. Simulation techniques make it possible to acquire this knowledge prior to the huge investments needed to bring these systems to a real-world testing state. (Bettencourt and Lactera, 1992)

Combat systems development goes beyond the mere testing of machines. It must assess the impact of the human dimension on the system. DIS has the ability to provide a realistic environment at all levels, from command and control to the soldier in the field. In light of the continuing requirement to support the decision making behind force modernization, this multilevel simulation capability is invaluable. It enables tactics and doctrine to be developed, tested, and refined by examination in the context of a fully represented battlefield environment. These simulated environments allow early determination of the performance of a new system or concept on the combined arms battlefield. (Bettencourt and Lactera, 1992)

Ultimately, DIS offers a realistic training environment with less expense than is normally incurred by traditional training methods. Manned field testing methodologies consume great amounts of manpower, resources, and dollars. Furthermore, they do not allow operational testers the unconstrained environment needed for the development of systems of ever increasing size, speed, and capability. Large savings in funding, manpower, and ammunition costs are a direct result of the applied simulation techniques that are offered by DIS. Additionally, there is usually a significant reduction in risk and an opportunity to gain a better understanding of requirements when traditional training methods are replaced by simulated training procedures. (Bettencourt and Lactera, 1992)

E. MULTIMEDIA DATA MANAGEMENT SYSTEMS

1. Weapons Effect and Performance Data Archive

The locating of data gathered during battle has always been a weak link in intelligence activities. Desert Storm, with all its positive results, demonstrated that this problem is as prevalent now as it ever has been. Because of the difficulties associated with locating battle data, it was virtually impossible to gauge the effectiveness of coalition actions during that confrontation.

Weapons Effect and Performance Data Archive (WEAPDA), a multimedia data archive that is run by the Defense Nuclear Agency (DNA), is designed to alleviate the problem of lost data. WEAPDA is a luggable system that can be brought into the theater so that the results of battle actions can be archived as data is collected. It is capable of cataloging video footage, damage assessment photos, videotaped interviews, satellite images, and text. For the first time, tactical officers are able to bring information management tools into combat with them. These tools enable them to systematically archive data as it is gathered, thus reducing much of the lost data problem. (McCarthy, 1994)

The quick data capture rate of WEAPDA increases the likelihood of accuracy and completeness in damage assessments. To this end, developers have added the hardware (Field Capture System) and software (Combat Capture System) to make early capture more effective. (McCarthy, 1994)

WEAPDA has proven that it can catalog video footage from aircraft gun and bomb cameras, transmit damage assessment photos, videotape post-mission interviews, satellite images, and text about weapons and timetables. There are also fields for adding up-to-the-minute digitized voice narration by pilots and follow-up ground photos. (McCarthy, 1994)

2. Deployable Mass Population Identification and Tracking System

The Deployable Mass Population Identification and Tracking System (DMPITS) was developed as a cooperative effort between the Immigration and

Naturalization Service (INS) and the U.S. Navy. DMPITS is used to keep track of the more than 30,000 Haitian and Cuban refugees at Guantanamo Bay, Cuba. The first part of the system is the identification subsystem. It is used to collect and record the identifying data. The second part, the records management subsystem, keeps track of refugee records as long as the refugees remain in the system. (Minahan, 1994)

DMPITS combines an automated fingerprint identification system with video imaging technology. Together, with the accompanying data base, they combine to create comprehensive refugee records. These records have the advantages of simplicity for quick construction and the integrity that comes from the ability to discourage and detect deliberate tampering. Each refugee in Guantanamo is assigned a radio frequency identification (RF/ID) band. The bands emit identification numbers that are unique to the individual to whom they have been assigned. Secured to the wrists of the refugees, the bands are read by a hand-held device. ID numbers that are associated with the bands establish records of individual refugee records. If the bands are removed or lost, refugees can be identified by their fingerprint or identification image. (Minahan, 1994)

3. Digital Multimedia Information System

The Digital Multimedia Information System (DMIS) is an information system for maintenance applications. It provides technicians with an integrated source of information from various media, such as video still images, graphics, text, and assembly drawings. Data from these sources are gathered, compiled, and integrated into a cohesive delivery script. The script is then synchronized and placed in an interactive environment. (Willis, 1991)

DMIS has the potential to use a variety of interactive input/output choices. Included among them are speech capability, expert system applicability, interfaces to a common data base, and the ability to accept Continuous Acquisition and Life-Cycle

Support (CALS) initiative deliverables for presentations without regeneration. Files and interactive scripts are stored in digital form on an optical disc. (Willis and Knapp, 1991)

DMIS has two primary purposes. The first is to automate the collection of preselected maintenance information into the data base. The second purpose is to serve as a paperless maintenance information and data delivery system. The ability to display multimedia presentations is critical to DMIS systems. (Willis and Knapp, 1991)

The system does have some drawbacks. Because it is a relatively new concept, there is no budgeting history. This lack of background information increases the difficulty of making dependable predictions and cost analysis studies. The second drawback is that the user may not have the background to adequately specify and define an implementation plan for a program involving this emerging technology. This will ultimately affect planing and implementation efforts. (Willis and Knapp, 1991)

4. CASS Test Program Set Hypertext Guide

a. Test Program Sets

The maintenance of the complex weapons systems now in service throughout the military is becoming increasingly difficult. The cost, not only in terms of capital expenditures but also in terms of man-hours and equipment down-time, has become all but unmanageable. The most efficient and cost effective way of dealing with this repair and maintenance problem is the use of Test Program Sets (TPSs). The TPSs, which are run on Automatic Test Equipment (ATE), have the proven capability to improve repair throughput and to reduce spare parts inventories. (Brassel and Burkhart, 1992)

The use of ATE in support of complex weapon systems maintenance, while it is a workable solution to maintenance problems, has proven to be a cumbersome and inefficient process. It often forces entire test stations to be custom designed for a single weapons subsystem. The TPSs, complete with maintenance and

engineering support documentation, were imbedded in the dedicated ATE designs. Under this system, each maintenance site was required to operate large numbers of dedicated ATEs. The incompatibility of the ATEs among each other made it extremely difficult to reduce maintenance overhead. (Eiranova and Mann, 1992)

As weapons systems continued to grow in complexity, ATE and their associated TPSs demand increased management attention. It soon became clear that a standardized approach over the entire TPS life-cycle was needed to enable maintenance functions to keep pace with the growth (Brassel and Burkhart, 1992). Standardization took the form of the general purpose ATE. It placed weapons system dedicated TPS in the ATE. A single ATE, designed to support all systems in the inventory of each service, could then be fitted with TPSs that were designed for specific weapons systems. (Eiranova and Mann, 1992)

b. Consolidated Automated Support System

The Consolidated Automated Support System (CASS) carried the standardization approach a step further. CASS integrates a set of diverse maintenance tests into a common test system. The U.S. Navy was a prime player in the CASS effort. It recognized the need to replace the volumes of hardcopy support documentation with an integrated information system. Much emphasis was placed on the design and development of effective update and maintenance processes. These processes were needed in order to efficiently update the product throughout its life cycle. (Epstein et al, 1992)

CASS covers a much greater range of technical performance than that which was covered by the previous system of independent ATE/TPSs. Unfortunately, the greater range results in a more voluminous set of documentation. The Navy's response to the increased amounts of documentation was the modification of the CASS TPS guides. It automated them for use on PCs and logically connected the entire system through the use of hypertext. (Epstein et al, 1992)

c. *Test Performance Set Development Documentation*

TPS development documentation is primarily hardcopy in format. The preliminary draft consists of over thirty paper bound volumes of technical specifications, performance and operational data. These volumes represent over 10,000 pages of narrative explanation, supporting diagrams, tables, charts, and program examples. Each system function is documented as a stand-alone volume with references to interrelated station and system control aspects. This documentation structure makes it most difficult, if not impossible, for the user to effectively access information as needed. (Epstein et al)

Weaknesses in the current military standard format include:

- Redundancy of material across multiple volumes
- Different authoring systems
- Incompatible formats for separate volumes
- Weak cross referencing links
- Data inconsistency
- Inaccuracy in the update material
- Inefficiencies in the update process

An attempt to alleviate many of the above weaknesses was made by creating an on-line reference, multimedia information presentation system. This system, called the CASS TPS Hypertext Guide (THG), was designed exclusively for CASS TPS Developers. (Epstein et al, 1992)

The hypertext environment greatly enhanced THG's capacity for consolidating, reformatting, and integrating the CASS documentation system. Perhaps the greatest advantage is the nonlinear interconnectivity of hypertext and its close resemblance to the design process. The flexible and user-transparent qualities of the technology facilitates its use as the principle means of accessing information. (Epstein et al, 1992)

CASS THG is made up of two subsystems, the Reader Subsystem and the Development/Maintenance Subsystem. The Reader Subsystem enables the user to navigate through pertinent, relationally linked information. This information can be in the form of specifications, instructions, figures, tables, or charts. The user's ability to incorporate bookmarks and personal annotations five CASS THG added value to the TPS developer. (Epstein et al, 1992)

The Development/Maintenance Subsystem is the second subsystem that comprises CASS THG. It offers the user such features as an intuitive authoring environment, text and graphics integration, text searching, navigation tools, embedded programming language, application and document window customization, object and link editing, and extensive text formatting. (Epstein et al, 1992)

d. Benefits

There are several benefits that will be brought by widespread implementation of CASS THG. The first of these is a significant improvement in productivity and economy of TPS developers. This will be a direct result of standardized and readily available methods of designing efficient test strategies. CASS does this by integrating a number of diverse manuals that cover wide range of CASS operations and performance data under a more flexible information management and presentation paradigm. (Epstein et al, 1992)

The adoption of an interactive hypertext environment is the second benefit derived from the CASS THG system. The hypertext allows the TPS developer to efficiently and conveniently navigate throughout the documentation. (Epstein et al, 1992)

The ability to add comments, reasoning, or techniques as annotations to the system is viewed as another benefit of the system. The annotations, which can be used as aids in the troubleshooting process, save valuable time and resources. (Epstein et al, 1992)

The substitution of hardcopy documentation with electronic media is yet another benefit derived from the use of CASS THG. It pushes the Navy closer to its

paperless solution to space limitations while providing a more efficient and timely means of end user distribution. (Epstein et al, 1992)

One thing is clear, CASS THG will change the way in which users treat large volumes of complex technical information. Digging through piles of unusable information for needed specifications, drawings, charts, and tables will become a thing of the past. Users control information representing thousands of pages of CASS system and TPS development information. Not only will the users be able to access the information more quickly and easily, but the system can also be used as a personal notebook that is capable of capturing the essence of a TPS designer's systematic approach to designing, developing, and integrating a CASS test program set. (Epstein et al, 1992)

F. INDUSTRIAL DESIGN AND TESTING

The Advanced Research Projects Agency (ARPA) has been developing a design technique called smart-model prototyping. This revolutionary new way of designing and manufacturing complex objects reduces costs, saves time, and is much safer than conventional design and development methods. ARPA's first efforts with the prototypes has been Navy ships and submarines. (Anthes, 1994)

What makes this virtual modeling technique unique is the use of the smart-model prototype. Much more than just a visual rendering, the smart model consists of linked databases and modeling software that completely describe an object's characteristics. The links with real-world characteristics enable the prototypes to obey the laws of physics. When they are subjected to virtual winds, heavy seas, storms, and other such natural challenges the models respond in the same manner that the real ship would when placed in similar conditions. (Anthes, 1994)

The technology was proven during the Iraqi conflict. Tasked with finding the means to speed Navy ships to the Middle East, designers tried several new engines in a virtual ship. The use of the model enabled the designers to determine, in

approximately four hours the engine characteristics that best met the needs of the Navy. Conventional development methods would have taken at least three or four months to complete the real-world design and development processes. (Anthes, 1994)

The use of multimedia techniques in naval industrial work centers is expected to increase. Thousands of military and corporate design and manufacturing people will collaborate in remotely distributed teams. Immersed in a virtual environment, designers in Virginia, vendors in places as far-flung as Detroit and Germany, and military officers at the Pentagon will all collaborate as if they were under one roof. (Anthes, 1994)

The advantage, of course, is to be able to concentrate on visualization and checkout without spending time and resources on real-world models. The days of the full-scale wooden mock-up of proposed ship design are numbered. Instead, virtual prototypes are being placed in simulated environments. (Anthes, 1994)

G. RESEARCH AND DEVELOPMENT

Research and development efforts are beginning to rely more heavily on multimedia systems than they have ever done in the past. This reliance has caused the human-computer interaction to become a primary concern of researchers and system developers alike. (*Signal*, 1993)

Just as the limited funding environment of today's DoD has resulted in a greater reliance on simulations for training purposes, the use of simulations for the testing of equipment is getting more attention in these days of austere budget cuts. Modeling, control, and agent data sources are all components of a virtual environment system. Modeling is the principle means by which the appearance and behavior of a virtual object can be made. The handling of multiple agents, the resolving of conflicts, and the satisfying of user requests at acceptable rates are control element determinations. The agent data sources determine the different types of data that can be presented to the control system for processing. (*Signal*, 1993)

The Naval Research Laboratory's (NRL) Effectiveness of Naval Electronic Warfare Systems (ENEWS) is a computer simulations environment that is designed for the assessment of tactical and training requirements. Research on targeting, jamming tactics, signal analysis, and mission planning is enhanced by ENEWS. (*Signal*, 1993)

ENEWS program's research and development is based upon computer simulation. It gives the researcher the ability to visualize that which cannot normally be seen. Radar beams, for instance, can be seen in three-dimensional, virtual reality space. (*Signal*, 1993)

There are numerous ways in which virtual environment technology can be used to enhance the analysis of an electronic warfare simulation. Multisensory output devices, for example, increase the ability to convey information. This provides an immersive interface that gives depth and spatial cues that are not obtainable with traditional displays. (*Signal*, 1993)

The system provides a means of assessing the complete electronic warfare environment. It uses three distinct but complimentary simulation tasks that contribute to the final analysis of electronic warfare system performance. These tasks are:

- Simulations to evaluate the capabilities of an electronic warfare system.
- Laboratory simulations on scale models that allow scientists to make precise measurements.
- Performance characteristics from field simulation that are later analyzed in actual operations conditions. (*Signal*, 1993)

The primary tasks to which ENEWS' has been assigned is the investigation of new technologies and the building of an infrastructure on which useful applications can be produced. Much emphasis has been placed on input and output devices. Configured and laboratory tested, these devices are operational but have not yet been integrated in a formal manner. They include a spatial audio system with external speakers used to simulate localized sound, a head-mounted, low resolution liquid

crystal display, a hand gesture input device, and a biofeedback input device that reads electric impulses from the body for eye movement or muscle contraction. (*Signal*, 1993)

Multimodal interface techniques used in ENEWS have been used to improve and increase the flow of information. For example, in one study the visual display was augmented with audio feedback. The parameter space of an emitter was mapped to the parameter space of sound in pitch, volume, and duration. Changes of conditions within the simulation were followed with the use of patterns that are naturally discernable to the researchers. (*Signal*, 1993)

The use of three-dimensional graphics is a tremendous improvement over the more traditional two-dimensional graphics. Projected onto high resolution screens, they provide the analyst with depth, volume, and spatial information that is normally not available. The representation of an antenna pattern as a three-dimensional surface, for example, enhances the analyst's ability to identify the gain at a specific elevation and azimuth. (*Signal*, 1993)

H. CONCLUSIONS

Information technology within the Navy is moving along similar lines as information technology elsewhere. Information sharing, consolidation, and integrated services are gaining domination in developing systems. Restricted financial resources will continue to enhance DoD's view of commercial off-the-shelf (COTS) services and equipment. Open systems principles will support multimedia workstations and multi-level security applications. (Vogelzang and Hodge, 1994)

In an attempt to standardize the diffuse array of military information systems, DoD has augmented the role of Defense Information System Agency (DISA). The agency has expanded to include global information processing and information transfer services via the Defense Information System (DIS). (Vogelzang and Hodge, 1994)

DIS is the aggregation of all mobile and fixed DoD information systems. Sensors, data entry devices, communications networks, computer resources, and facilities are all a part of the system. Also included are the operational and support staff that are organized to provide protection, collection, production, storage, dissemination, and display of information for the DoD. (Vogelzang, and Hodge, 1994)

The Defense Information System Network (DISN) is a subset of DIS. It provides end-to-end information transfer and value-added network services for DIS-supported networking and communications services. (Vogelzang and Hodge, 1994)

For the near-term future, DISN must face demands for increased automation, reliability, integration, deployability, and interoperability. Unfortunately, there are with fewer budgetary resources available to meet these demands. There are also some requirements that are somewhat unique to the Navy. Surge capacity, security, precedence, and survivability are examples of these requirements. These features must be incorporated into commercial network subsystems. (Vogelzang and Hodge, 1994)

The future DISN will grow from today's telecommunications infrastructure. It will include the DoD information transfer system that provides the communications infrastructure and services needed to satisfy C^3I requirements. DISN will work with civil and commercial systems, North Atlantic Treaty Organization (NATO)/allied systems, and special systems such as those developed to support National Security and Emergency Preparedness (NS/EP) users. (Vogelzang and Hodge, 1994)

V. CONCLUSIONS

A. MULTIMEDIA REVOLUTION

The information management field has weathered rapid and continuous change. Some of these changes have been so broad and have brought such a high degree of realignment to the industry that they have been termed "revolutions." The latest of these revolutions was the explosive growth in desktop computing of the 1980s. During the first half of the present decade the information industry has been building toward another revolution. The implementation of multimedia has started a chain of events that has the potential to change computing just as dramatically as the advent of the desktop computer did a few years ago.

The key driving forces of the emerging multimedia revolution are the demand for rich information technology, the push toward global standards, ever-increasing customer demands, and growing global competition. Neither the stand-alone, single-user computer nor the isolated departmental LAN can support the demands that these forces are placing on information resources. Networking and distributive computing are multiplying the effectiveness of today's computers, thus enabling them to meet the challenges that they now face.

Advances in telecommunications are enabling what was two distinctly different movements in the information industry, the movement toward distributive computing and the adoption of multimedia, to converge. The results of this convergence may be as spectacular as any past change in information management.

The older, more traditional command-and-control model of management is rapidly being replaced with a newer information-based model. The U.S. Navy needs to pay very close attention to the changes that information technology is making in the business computing environment. Distributed multimedia communications will have an especially dramatic impact on the nature of work, and will therefore have a broad impact on the way business will be done, both in and out of the Navy.

B. THE NAVY'S ROLE IN THE MULTIMEDIA REVOLUTION

The Navy needs to maintain control over the new multimedia systems as they become available to the service. Lessons learned should be reviewed with the intention of avoiding the same mistakes that were made with the introduction of desktop computing in the 1980s. The naval service cannot afford to underestimate either the impact of distributed multimedia computing or the speed at which the new technology will race through its ranks. Building the architecture now, before anticipated multimedia changes take place, is crucial to the control of Navy information systems.

The first thing that must be done is to define "multimedia" in terms that makes the most sense for the Navy. With that definition firmly entrenched, current usage should be reviewed and the desired level of multimedia computing defined. Then it is merely a matter of calculating how we are going to get from where we are to where we want to be.

Strategic thinking must dominate each decision to incorporate multimedia systems into existing Navy networks. The central issue should revolve around goals, the cost of achieving them, and the return on investment in multimedia systems. Non-monetary concerns, such as the quality of training, the effectiveness of inventory controls, and the efficiency of communication, should also be considered.

C. PERSONNEL

When bringing new multimedia systems online the emphasis must be on people and how the systems will affect them. It does little good to introduce any new system if the personnel who are to run the system cannot, or will not, use it. Ambivalence, like ignorance, leads to under-utilization of available assets and the possible destruction of efforts to bring perspective systems online.

Bringing distributed multimedia systems into organizations requires cultural change along with the technological advancements. Changes in the work force are

part of the continuous reengineering of society with which we are all involved. While many of these changes are beneficial to Navy members, some require sacrifice on the part of involved personnel. In any case, all changes require some degree of adjustment on the part of the personnel. One difficulty that the Navy shares with most federal organizations is that it is most reluctant to change. Bureaucratic organizations, which tend to be cautious and conservative, have reputations of being "hard sells" when it comes to adapting to new information systems. The reluctance can be traced to any number of sources, from anxiety about computers taking over jobs to the fear that machines will be substituted for direct customer contact.

Multimedia has the ability to bring the naval service closer to that most elusive target, the paperless Navy. However, the Navy mindset indicates that this will require a massive cultural shift before it will become a reality. The concept of electronic documentation is not easily grasped. The need to physically handle and file hardcopy reports and documentation is, for many, too deeply imbedded in their cultural habits to be easily overcome. So far, the "computer revolution" has resulted in an increase of paper rather than the anticipated lessening of it.

Navy information managers need to view potential systems from the end user's perspective. That is to say, they need to see the system as an improved means to communicate. The user sees the technology that is so important for the Systems Administrator as merely a means to manipulate data and communicate with other users.

The implementation of change management techniques will help gain user confidence in, and support of, new distributed multimedia systems. Personnel training is a part of the techniques. The training should go beyond the technical training that most services do so well, and get to the reasons why new systems need to be brought online. The users need to understand that "their" new system is part of the Navy's attempt to make more effective use of available information, a means that will enable them to perform their jobs more efficiently and effectively.

Another concern is the basis for multimedia system design. These systems should be designed with the content in mind, rather than technology. Designers need to recognize that leading-edge systems are not always the answer. Sometimes a more simple one will suffice. A relational multimedia database system, for example, need not be designed when a text-only flat file system will suffice. Organizational assets are better spent elsewhere.

D. MULTIMEDIA ISSUES

With its full motion video, stereo sound, and high-end graphics capabilities, perhaps the greatest value of multimedia is its usefulness as a link between users and formal organizational information systems. Its role in user interfaces is helping to push the efficiency of user interaction with these complex information systems to new heights.

Multimedia applications do more than allow human users to communicate and share resources. They also link machines and systems. Multimedia's potential for doing work cannot be over stated. Its strength is its ability to condense large amounts of data into a format that is intuitive and useful for today's users.

There are problems that need to be solved when bringing multimedia systems on line. Integration and network management are two of the greatest difficulties. Integration enables the various media types to work together in a synchronized fashion. This is especially important when working with time reliant media types like video and audio. Proper network management will alleviate the problems with stove-piped systems and isolated departmental networks that are so prevalent in current naval systems. The objective is to replace them with enterprise networks based on open systems architecture and standardization.

One of the outcomes of the current budget cutting climate that has enveloped the federal government is the forcing of cooperation to new levels within the DoD. Open systems architecture and standardization are two themes that need to be emphasized as the Navy reaches for higher levels of joint-service cooperation.

Projects like the Corporate Information Management (CIM) initiative are leading the way toward the enterprise systems of the future. Multimedia interfaces have the potential to help make joint systems a functional reality.

E. DEPARTMENT OF DEFENSE ISSUES

The same problems that plague DoD information systems usually affect multimedia systems in a similar manner. Some of the more profound difficulties include those that deal with acquisition, standardization, interoperability, integration , and communication. DoD has recognized the magnitude of these problems and has implemented a number of programs that will offer some relief to the situation.

1. Corporate Information Management Initiative

The Corporate Information Management (CIM) Initiative is the largest information management program ever conceived by any U.S. business organization. It provides technical guidance to DoD components in the areas of acquisition, development, and support for DoD information systems.

CIM is a managerially sound process for organizing information management functions through information resources management methods. It represents a total rethinking of DoD business processes. (Haycox, 1993)

The CIM Initiative's primary objective is business process improvement. Concentrating on cost optimization and improved performance, it is designed to bring contemporary business practices to the DoD. It is also seen as a means to shorten the elapsed time for systems development, to allow for incremental growth, and to add fully-tested major new functions to an already existing application set. As originally conceived, CIM is to stop at nothing short of the modernization of the Defense information infrastructure. (Strassmann, 1994)

It is fortunate that the maturation of distributed multimedia is occurring after the CIM Initiative's implementation process has begun. CIM's insistence on

enterprise systems and sound managerial methodologies should maximize benefits from the emerging multimedia systems by ensuring that the applications are flexible enough to support a variety of users throughout DoD.

2. Defense Data Interchange

The Defense Department operates a huge array of heterogeneous information systems. A number of different computer architectures, operating systems hardware, programming languages, and communications protocols make it difficult for these systems to interoperate. The advent of multimedia systems, with their inherently complex structures, will compound this already difficult situation. To counter the problem, DoD is working on a streamlined procurement network that is composed of electronic commerce systems that link government with business. (Meadows, 1994)

A standard approach to electronic data interchange is urgently needed. The Defense Data Interchange (DDI) is an attempt to fill this need. The DDI encompasses the electronic transfer of business information in a standardized electronic form between the government and other parties. (Meadows, 1994)

3. Defense Information Management

This wide-ranging initiative attempts to simplify the redundant data management functions that are present in the multiple DoD systems. Its objectives are to separate data from applications, maintain single-entry procedures, standardize data throughout the agency, move to a centrally managed distributed database environment, optimize use of commercial off-the-shelf products, and implement open-systems standards. As more DoD services and agencies incorporate multimedia systems on their networks, the need for Defense Information Management will increase. (Meadows, 1994)

4. Multimedia Standards Working Group

The Multimedia Standards Working Group (MSWG) was established for the purpose of providing a forum for coordinating DoD positions on multimedia standards and standardization issues. Its tasking is to influence the development of federal,

national, and international standards that reflect DoD multimedia requirements. It does so by developing and inserting DoD enhancements into these multimedia standards. MSWG works closely with organizations like the American National Standards Institute and the International Standards Organization. (DISA, 1995)

MSWG is comprised of technical representatives from services and agencies with expertise in multimedia management. These representatives can come from any government agency, including DoD representatives to nongovernmental standards bodies that are engaged in multimedia standards activities, and representatives from industry and national standards organizations. (DISA, 1995)

MWSG's primary function is to promote compatibility and interoperability of multimedia systems through the use of standards, specifications, and profiles. It also advocates partnerships with government and non-government organizations, maintains relationships with other working groups, and forms ad hoc working groups. (DISA, 1995)

F. APPLICATIONS

It is most difficult to predict which applications will provide the most benefit to the Navy. A few broad generalities concerning the use of multimedia can be made at this point, however. These generalities include the use of such information management techniques as compound document, teleconferencing and telecommunications, Multimedia Mail Service, and remote and simulation training.

1. Compound Documents

The concept of compound documents is reshaping information management practices in both civilian and government organizations. It represents an emerging technology that has the ability to simplify the design and implementation of complex software applications. Compound document technology is most noted for its inherent capability of simplifying user interfaces for end-user applications. (Adler, 1995)

Due in part to its object-oriented base, the idea behind compound documents is tied closely to the client/server architecture for distributed computing. Applications

such as OpenDoc from Component Integration Laboratories and Microsoft's OLE 2.0 are bringing object-oriented concepts into the mainstream of application development. (Adler, 1995)

Compound document technology is transforming the way software applications interact and appear on screen. Users perceive the technology as a means of simplifying their operations. To them, it is an interaction model that enables the user to move data within and across distinct compound documents. Information specialists, by contrast, view compound document technology as the the solution to the problem of accessing unstructured information - the need to retrieve not only data with associated attributes, but also full text, pictures, graphs, and voice. (Adler, 1995) (Al-Hawamdeh and Loke, 1991)

Compound document technology is a shift from application-centered to data-centered models. It is this shift that enables the user to create documents that appear functionally and seamlessly integrated without regard for location of the source document. (Adler, 1995)

One can think of the compound document as a unifying container for sharing heterogeneous data. It does more than manage the presentation of, and user interactions with, data and applications. It also maintains associations between data and the applications for creating and manipulating the data. Perhaps most importantly, it provides interfaces that facilitate application interactions to exchange data and invoke one another's services. (Adler, 1995)

The value of compound document technology is that it provides an integrated, homogeneous way to access, process, and exchange multimedia information (Al-Hawamdeh and Loke, 1991). It does so by presenting an object-based framework for manipulating and storing heterogeneous data, thereby facilitating data sharing and exchange across disparate applications. (Adler, 1995)

2. Teleconferencing and Telecommunications

Shore to ship teleconferencing is one of the more exciting developments. When security problems are overcome teleconferencing's positive impact on the

Navy's mission will be incalculable. No longer will ships be isolated from their ashore commanders. Electronic meetings can be held until the last few minutes before engagement.

Meanwhile, at shore-based support activities, developments in multimedia telecommunications are making the possibility of remote collaborative work more realistic. Virtual committees and boards enable widely disbursed people and activities to work side by side. Location is no longer a limiting factor when the need to draw the most suitable personnel together arises.

3. Multimedia Mail Service

Multimedia Mail Service (MMMS) is another communications service. It enables users to exchange electronic documents containing several representation types. Voice, high-resolution graphics, and even video can be combined with text to bring much greater standards of clarity and understanding to messaging services.

4. Remote and Simulation Training

Many professional educators are quick to point out that learning is a social process. The effect interactivity has on training is cited as a direct result of the social aspects of the training environment. Multimedia increases the interactive aspects of training in both the traditional classroom and the remote classroom of a distance learning situation. Training through simulation is now a most respected field, largely due to the success it has achieved and the resources it has saved by limiting the need to use real-world assets.

G. CONCLUSION

The information management industry is at an exciting point in its history. Multimedia, through the use of varied data types, is bringing more information to the user than traditional information systems. It does this in a more intuitive manner, thus providing a higher degree of effectiveness for the organization. In the long run, cost savings can be substantial. Multimedia helps give people faster access to each other and to distributed information.

The merging of communications, computers, consumer electronics, and entertainment that has lead to distributed multimedia has traversed the chasm from amusing entertainment technology to serious element of corporate and government organizations. Those who are reluctant to relinquish familiar legacy systems must remember that those solutions that have worked so well in the past may be totally wrong for the today's challenges.

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